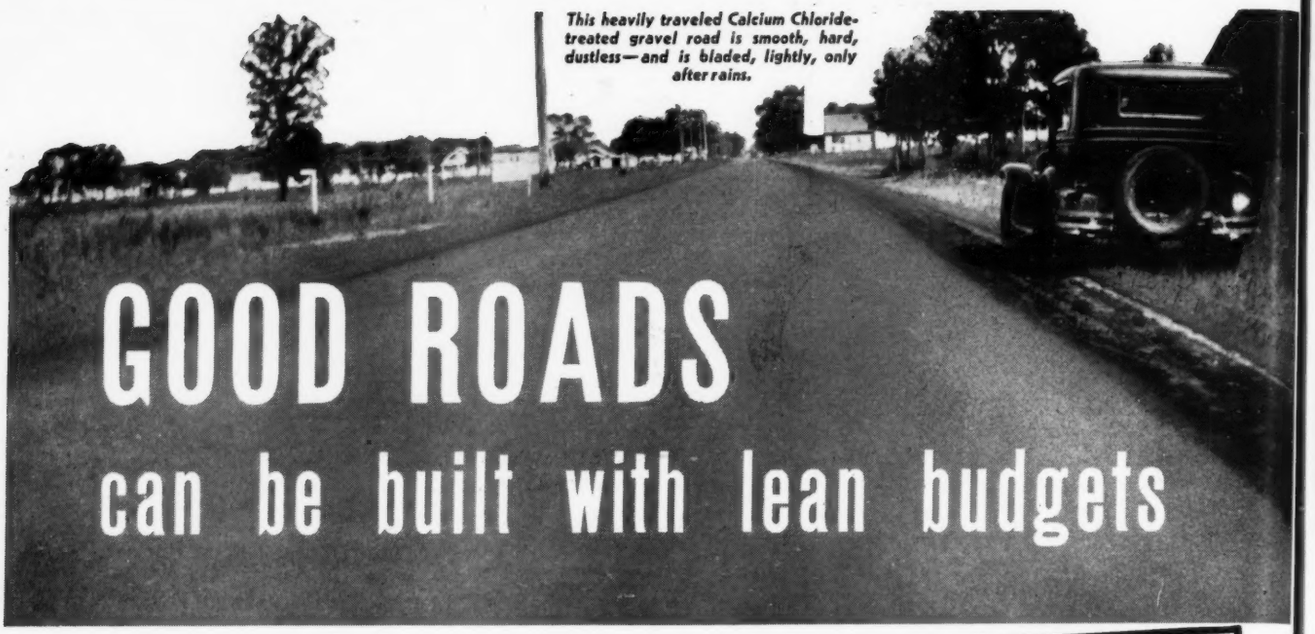
City, County and State

MAR 15 1934

PUBLIC WORKS

Sewerage and Sewage Treatment | Highways and Streets | Water Supply | Refuse Disposal | Construction and Engineering

MARCH, 1934



This heavily traveled Calcium Chloride-treated gravel road is smooth, hard, dustless—and is bladed, lightly, only after rains.

GOOD ROADS
can be built with lean budgets

"ROAD STABILIZATION" ***is here . . . a perfected, tested and Government-approved method of low-cost hard-surfacing that means a*** **NEW ERA IN SECONDARY-HIGHWAY CONSTRUCTION.**

AMERICAN ingenuity is ever determined to conquer situations of stress or obsolescence. Out of the depression comes the practical perfection of "road stabilization"—a type of surface that is amazingly smooth, hard, dustless, long-lasting . . . and attainable at but *a fraction of the cost of the usual pavement.* In fact, its cost is virtually no greater than the maintenance expense alone of the average unbonded gravel road.

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Stabilized traffic-bound roads are no longer an experiment. On many miles, in all sections of the country, they have been proved for efficiency, stand-up qualities and construction and maintenance economy. They definitely represent: (1) *Lowest initial cost;* (2) *All-weather hard surface;* (3) *Conservation of road material;* (4) *Reduced blading and smoothing cost;* (5) *Increased effectiveness of surface treatment (dust laying);* (6) *Adequate improvement for two-thirds of the country's road system.*

Write immediately for extensive literature on costs, specifications, practices and actual experiences. Address any of the following members of the CALCIUM CHLORIDE ASSOCIATION:

●

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THE DOW CHEMICAL COMPANY . . . . Midland, Michigan
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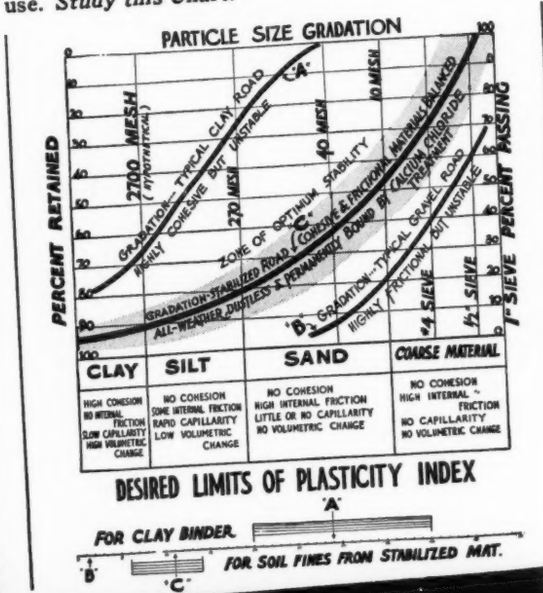
A stabilized low-cost road is a mixture of local materials proportioned to balance the frictional and cohesive characteristics of the ingredients and to maintain its consistency and consolidation through moisture constantly supplied by Calcium Chloride. Nearby gravel, fine stone or slag; some clay-soil as a binder; and space-filling sand and silt —are used. They cost little or nothing. No expensive machinery is needed. Unskilled labor, mostly, can be employed. Properly proportioned, these materials, with Calcium Chloride treatment, form a moist and dense mass. Traffic itself compacts it. Particle displacement or movement is eliminated or reduced to the minimum. No drying out or rapid separation and raveling; no heavy loss and replacement of materials. Blading is required only at rare intervals; and only an occasional subsequent surface treatment of Calcium Chloride is needed to maintain these roads efficiently for long periods of use. *Study this Chart.*



CALCIUM CHLORIDE for stabilizing road surfaces

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March 1934

PUBLIC WORKS

Vol. 65 No. 3

CITY, COUNTY AND STATE ENGINEERING AND CONSTRUCTION

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TIMEWASTERS

"Timewasters, bah, and a couple of poohs" says Walter S. Wheeler from the presumably ice-bound regions of New Hampshire. Come seven, come eleven. Just eleven minutes on the match problem.

Also along comes a whole flock of solutions from Don Hastings, of the Twin-Flex, Detroit, also presumably an ice-bound region these days. He solves the beggar problem, contributes a few words on the problem of Mr. Eisner's in the December issue, and gives the answers to Mr. Clark's problem in the same issue. He says he has already developed two solutions to the match problem, but wants to give it further study.

The three numbers referred to in Mr. Clark's problem are 486, 648 and 864. Mr. Hasting's solution of the problem submitted by Mr. Eisner is a little over our head when he says "infinite number of solutions. . . . all in hyperbolic surfaces in three dimensional space." Maybe our readers will understand.

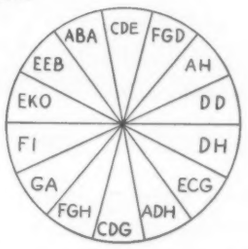
There are two solutions to the match problem, but the approved solution, as the army says, is:

One match is lifted from the left of the equation to make the V into a square root sign.

The answer to the beggar problem is that each beggar starts with 696 coins. As can readily be computed, there was lots of borrowing.

Not the Water Wheel:

The neatly drawn wheel below contains 14 sectors, in each of which appear letters. Each of these letters represent digits, for instance CDE may represent 245. The squares of the sums in any two adjacent sectors are equal to the squares of the sums in the two opposite sectors. Now, gentlemen, what digits do the various letters represent?



It will be noted that the wheel is divided into 14 sectors. In trying to divide the wheel above into 14 accurately divided sectors, we had some cause to wonder if, after all, that wasn't the problem; or perhaps that Bob Clark, who turned this in, wasn't playing a joke on us. Can some one tell us a quick and accurate way of dividing a circle into 14 segments? Thank you.

Two Minutes on This:

S. Cameron Corson says: "Here is an old-timer. Don't ask questions, but do it.

If the third of six be three
What will the fourth of 20 be?

SUBSCRIPTION RATES: United States and Possessions, Mexico and Cuba, $3.00. All other countries, $4.00. Single Copies, 35 cents each.

A. PRESCOTT FOLWELL, *Editor* **W. A. HARDENBERGH,** *Asso. Editor*

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PUBLIC WORKS

City, County and State Engineering and Construction

Vol. 65 — *March, 1934* — No. 3

What City and County Engineers Think of the CWA

ENGINEERS are proverbially conservative, and the general feeling about city engineers is perhaps that they are especially so. In view of this, the attitude of the city engineers, and also of the county engineers, throughout the country regarding the CWA is of considerable interest.

In a recent questionnaire sent to more than 2,500 city and county engineers, a number of questions were asked regarding the type of work done under CWA projects, what the results of CWA work has been in regard to the city, to local business, and to local labor; whether the engineer would like to see such work continued; the proportion of money that went to labor, to materials, and to equipment; what percentage the city or county contributed and to what extent such work has reduced expenditures for relief.

Types of Work Undertaken by Cities

Most of the types of work carried on were worthwhile in character. It is a tribute to the ability of the city engineers that they were able to work out, on short notice, projects that employed large numbers of men, little machinery and little equipment, and yet had a real value to the community.

Some of the types of work mentioned were: Grading and surfacing streets, park development and improvement, sidewalk construction, sewer construction, traffic counts, drainage, airport improvement, repair of public buildings, laying water mains, highway construction, swimming pool construction, playgrounds, retaining wall construction, resurfacing streets, constructing curbs and gutters, widening streets, and bridge and culvert construction.

Benefits from CWA Work to Cities

More than 95% of the replies to the question: In your opinion have results of CWA been worth while to the City? were "Yes." There were a few flat replies of "No," but most of those who disagreed qualified with such remarks as "not particularly," "yes, but at a very high cost," "some," etc.

To the question, "Has the CWA aided local business?" the replies were even more favorable, less than a dozen of nearly 700 replies expressing a negative or even a doubt. In regard to the benefit to labor, there were almost no negative replies.

Should the CWA Be Continued?

The question whether or not the CWA should be continued brought out the greatest variety of opinion, but even in this case 84.4% voted "Yes." Many of these replies, as in the case of the questions previously discussed, were underscored or capitalized to show the strong feeling of the writer.

Of the 15.6% who objected to a continuation of the CWA, about one-fifth replied with a flat "No." A similar number stated it should not be carried on past May 1; others qualified with such statements as "through the winter," "for a short time," "if it can be financed" and "yes, with changes."

How Much for Labor, for Equipment, for Materials, by the City?

The amount of money that went to pay labor varied from 35% to 98%, with an average not far from 75%. Because nearly all of these averages were expressed in percentages, a weighted average cannot be obtained. Of the remaining 25%, approximately half went to materials and half to equipment. In general, most of the 25% that went for equipment and materials was contributed by the local community, but not always; practice in this regard varied materially with the different states. In many cases, the cities contributed nothing; in others 5%. One Texas city contributed 55% of the total, using all of this for materials and equipment which went into waterworks and paving.

Reducing Relief Expenditures by Cities

Very material reductions in relief expenditures resulted from the CWA work. Comparisons or totals are difficult, because of lack of uniformity in answers. For instance, one California city reports a reduction in relief expenditures of $2,000 per week; another says "it has almost eliminated city relief"; another says that "money allocated for relief was spent for materials and equipment so the men could work better." Inasmuch as the city in this case furnished 22% of the total spent on CWA work, it was a large gainer.

A vote of confidence.

A Rocky Mountain city says "relief expenses reduced 75%"; a midwest city, 25%; a Kansas city, 75%; another Kansas city says "spent more for materials than previously for relief." This city provided 23% of the total CWA fund and built 44 blocks of asphalt paving, so the relief money provided something worth while. Likewise the county in which this city was located built 200 miles of county road.

A Nevada city says "relief expenditures by city during CWA practically nil." This city constructed gravel streets in the residential sections, recreation facilities at the school, and improved the city park. The engineer considers the CWA to have been "very" worth while.

Hundreds of other interesting comments were noted from the answers to these questions.

The County Situation

The county questionnaires were mailed a few days later than those to the city engineers, so that a smaller number have been returned. Of the 310 returned up to Feb. 24, a random sample of 171 was taken for examination.

The types of work generally handled included: Road widening; gravel surfacing; surface treatment; relaying brick and asphalt block; school building repairs; anti-mosquito work and rural sanitation (in the south); improving highway drainage; clearing right-of-way; "daylighting" railroad crossings; improving sight distances on highways; building traffic-bound gravel; crushing stone and building macadam roads; opening gravel pits for future use; constructing shoulders on narrow roads; bridge construction; building retaining walls; dam construction; and guard rail construction.

Benefits of the CWA—The County Engineers

In replying to the question: "Has the CWA been worth while to the county?" the answer was "Yes" by 160 of the 171; 6 said "No"; 4 gave a qualified statement and 1 did not answer. Regarding the benefit to local business from the CWA, 167 stated that local business had benefited; 1 did not answer, 2 did not know; and one said "some."

Regarding the benefit to labor, 1 said that labor had not benefited; 164 said it had; 1 was a blank; 2 gave qualified statements.

The greatest variety of opinion came in answering the question: "Would you like to see the CWA continued?" Of the 171, 136 said "Yes"; 10 said "No"; 4 did not answer; the other 21 were in favor of temporary (10) continuation, modification (7) or other method of handling.

Reduction in County Relief; Materials and Equipment

Widely varying figures were given here, as was the case with the city engineers. Estimates were from 30 to 100%, with an average around 65%, probably. One engineer stated that local business had increased 60%. Another states that with the CWA functioning, relief dropped back to the amount generally found in normal years.

With the counties, essentially the same figures held as with the cities, so far as percentages spent for equipment and material were concerned.

One Engineer's Statement

Of the many remarks written on the questionnaires by both city and county engineers, and of the wealth of information given by them, the following statement of a county engineer who approves the CWA and its results is perhaps most illustrative and sound:

"I think the CWA could be made to do a lot more good if the wage scale were modified so as to fit local wages. Under existing conditions, every one wants to get on the CWA work because they can get more wages, and the tendency is for labor to quit fair jobs with the hope of getting work where the wages are higher. More good would be accomplished by the CWA if there were closer supervision, and if suitable projects were picked for the season of the year in which work is to be done."

Much prominence has been given by the daily press to rumors of inefficiency, graft and worse in the spending of the CWA millions. There has been some of this, of course. Human nature being what it is, it would be impossible so to arrange, in two or three weeks, for the spending of such an enormous sum in thousands of localities, that there would be no instances of waste, favoritism and even dishonesty. But considering how many thousand men were hastily selected to supervise this work, it is remarkable that there has been no more misuse of the funds than has yet been discovered or even charged. No class of men have more intimate and sound information concerning the value of CWA work than city and county engineers; and when 95 per cent of them say that the results of this work to others than the workers themselves have been well worth while, we accept their opinion as decisive.

Water Supply Industry Code Hearing Indefinitely Adjourned

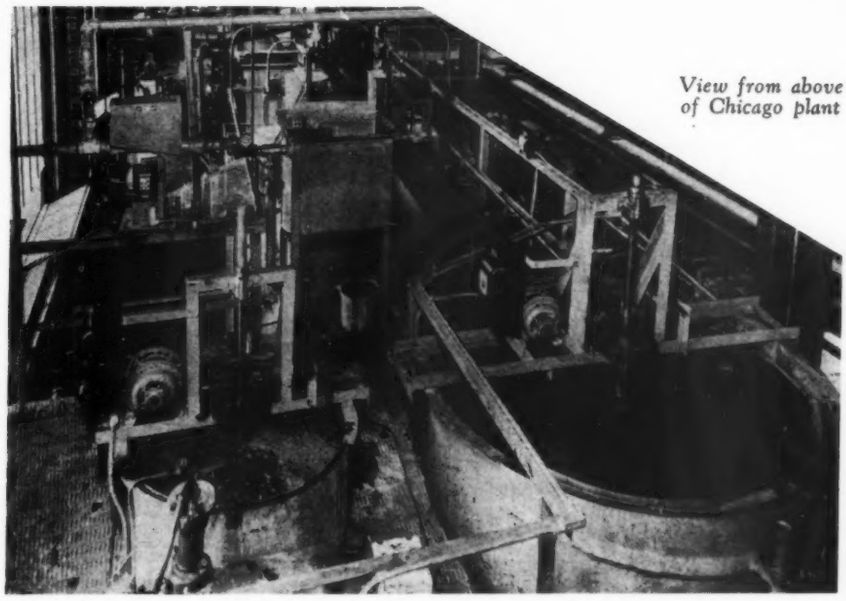
As we announced last month, a code for the water supply industry was drafted and a hearing on it announced by the NRA for February 6th. The hearing was postponed to the 20th, and the American Water Works Association appointed a committee to consider the code with particular reference to the personnel of municipal water departments. This committee consisted of W. W. Brush, Wm. G. Bank, Seth Van Loan, Wm. W. Hurlbut, Andrew B. Mauzy, Franklin Henshaw, and A. V. Ruggles. Their first meeting was set for February 14th.

On February 15th Administrator Johnson announced that the hearing on this code "is adjourned indefinitely. The submitted code for this industry has been withdrawn for the purposes of revision, whereupon it will be resubmitted, for consideration at a public hearing, at a time and place hereafter to be announced."

Welding Steel Pipe Reduces Friction

Friction loss in steel pipe, 30″ diameter, welded, coated with bitumastic enamel, was determined in 1933 in Pennsylvania. Three or four 30 ft. lengths were welded together and these lengths joined with Dresser couplings. In the 50,700 ft. tested there were 85 horizontal and 81 vertical bends with center radii of 6 to 10 ft., with 51 air valves at high points, and seven 30″ gate valves and 48 manholes. The test was run several months after the pipe line had been put into service. Tests made at velocities ranging from 0.68 ft. per second to 3.8 ft. gave values of C varying from about 131 for the smallest amount to 143.4 for the largest (12,093,000 g.p.d.) No allowance was made for bends, valves or other structural features affecting the loss in head.

Six Months' Operation of a Chemical Sewage Purification Plant



View from above of Chicago plant

Abstract of a paper read before the New York Sewage Works Association

By Maj. G. H. Gleason and A. C. Loonam

AMONG the sewage treatment processes and devices which have been tested by the engineer of the North Side Sewage Treatment Works of Chicago is a chemical process developed by engineers of Guggenheim Bros. This test plant treated about one million gallons a month of weak domestic sewage resulting from a water consumption of about 300 gallons per day per person, 4 to 6 hours old on reaching the plant, temperature 53° to 79° F. and with the following characteristics:

	Monthly Variation	*Average*
BOD (5-day).....	94.0 to 123.0 p.p.m.	103.0 p.p.m.
Suspended solids...	119.0 to 151.0 p.p.m.	133.0 p.p.m.
Total nitrogen.....	13.2 to 17.7 p.p.m.	16.1 p.p.m.
Ammonia nitrogen.	5.5 to 8.6 p.p.m.	7.4 p.p.m.
Organic nitrogen...	7.7 to 9.5 p.p.m.	8.7 p.p.m.
Organic carbon....	66.0 to 107.0 p.p.m.	83.0 p.p.m.
p^H	7.1 to 7.4	7.2
Bacteria (13 counts)	Total 850,000 col. per cc. B. Coli, 100,000 col. per cc.	
Hardness 165.0 p.p.m.		

The treatment plant at Chicago occupied a space 36 by 14 ft. The incoming sewage passed through a grit chamber and coarse screens and into a dosing tank 18 in. square by 5 ft. long, at the head of which was applied ferric sulfate solution containing 50 grams per liter of iron. Air agitation was used to disperse the soluble iron promptly and thoroughly and oxidize any ferrous iron present. After 4 minutes' retention here, it entered a second dosing tank 10 ft. long, where it received sufficient milk of lime containing 50 grams per liter of CaO to bring the pH to about 7.5, where it was retained for 8 minutes, with thorough air agitation.

It then entered a circular clarifier 6 ft. diameter and 8 ft. deep, being introduced along one-third of the circumference at an elevation of 6 in. above the bottom, passing upward through a blanket of sludge and overflowing on the opposite side after passing under a baffle board. Here it was retained for 1½ hrs. The sludge was moved to a central outlet by a Dorr type rake.

Treatment of the effluent was completed by running it through one of two zeolite reactors, each 36 by 27 in. containing 13 cu. ft. of 10 to 30 mesh zeolite, flowing downward at a rate of 0.6 ft. per minute. Each of the two units was in turn withdrawn from service for backwashing and regeneration.

The sludge from the clarifier was pumped periodically to a thickener 3 ft. diameter by 3 ft. deep, the overflow from which was returned to the first dosing tank, while the thickened sludge flowed to an Oliver vacuum filter. The filtrate from this filter was returned to the first dosing tank. The filter cake, about 75% moisture, was burned in an incinerator; first passing through a drier 1 ft. diameter and 6 ft. long insulated with slag wool and heated by waste gases from the incinerator, which entered at 675° to 700° C. and left at about 125°; the drier reducing the moisture to less than 8%. The incinerator was a steel shell 4½ ft. long with a refractory lining and an effective diameter of 10 in., to which heat was supplied by a blast burner using city gas. The dried sludge was charged continuously by means of a screw conveyor. The average heat value of the sludge was about 4,800 Btu per pound dry weight.

The incinerator ash, containing 30% to 32% iron oxide, was treated with 66° Be. sulphuric acid at 150° C. for one hour and the product leached with water in a rubber-lined steel tank. This gave a ferric solution which, diluted to the proper strength, was applied to the sewage in the first dosing tank.

This treatment gave an innocuous solid residue, largely silica, and a liquid effluent from the zeolite filter that was of excellent quality. There remained to be disposed of the matter in the filter, consisting of a small amount of suspended solids carried over from the clarifier; also, by a base exchange reaction, the soluble basic nitrogenous salts were concentrated in the zeolite bed. After about 24 hours' service, a zeolite reactor was taken out of service and the suspended solids removed by backwashing with purified sewage; it was allowed to

drain and brine solution (200 grams per liter) percolated through it, about 300 gal. (1% of the sewage treated) passing through in 2 hours. The spent brine was mixed with lime to liberate the NH_3 from its salts in the form of NH_4OH, the precipitated solids were settled out, and it then passed down through a rectifying tower, meeting vapors from a gas-fired boiler, and the NH_4OH was driven off and condensed. The liquid, containing about 0.10% to 0.15% ammonia, was then stored for use again in regenerating zeolite.

The incinerator, ammonia recovery, and iron recovery units were operated on the day shift only.

The rates of feed of iron varied from 20 to 45 p.p.m., but increasing above 25 p.p.m. did not improve results; and experiments for two weeks indicated that high degrees of purification could be obtained with much smaller amounts of coagulants than were used in the greater part of the test. Also varying the pH between 7.0 and 7.6 appeared to have no effect on the clarifier operation; but the higher pH was maintained to protect the zeolite.

Considerable was learned during the six-month test concerning increasing the effectiveness of the operation of the plant, especially the sludge filtration. The rate of filtering in the last month was 9 times that in the first month, secured by adding 40 lb. of lime per m.g. in the filter trough.

Various experiences during the test convinced the engineers of the Guggenheim Co. "that the process is not sensitive to either conditions of weather or variations in the type of sewage." The plant was operated during the test by the regular employees at the North Side Sewage Treatment Works, samples were taken by the Sanitary District employees under the direction of Dr. F. W. Mohlman, and all analyses made by the chemists of the district.

Results obtained by this test, grouped by monthly averages and the 6-month average, are given below. Results obtained by activated sludge treatment of the same sewage are given in parentheses.

5-Day B.O.D. removal, 88.3% to 95.0%; average 91.2% (89.0%)
Suspended solids removal, 96.0% to 99.6%; 97.4% (90.4%)
Organic nitrogen removal, 74.0% to 83.5%; average 79.3% (74.7%)
Ammonia nitrogen removal, 58.4% to 73.0%; average 67.4% (51.0%)

The per cent of solids in the clarified sludge varied from 3.8 to 6.5, averaging 4.8. The moisture in the filter cake varied from 74.4 to 79.1%, averaging 77.0% for each of the last two months.

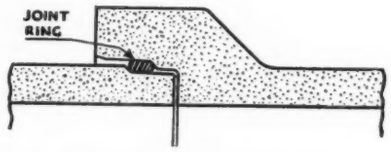
Thirteen bacterial counts were taken, averaging 850,000 total bacteria per cc at 37° in the raw sewage and 22,000 in the effluent (97.5% removal); and 100,000 B. Coli reduced to 2,300 in the effluent (97.7% removal).

Of the chemicals used, the iron dose varied from 19.5 p.p.m. to 38.5 p.p.m. and the lime from 31.6 p.p.m. to 52.9 p.p.m.; salt 800 to 1,000 lb. per million gallons, sulphuric acid 865 to 1180 lb. per m.g., and lime 484 to 670 lb. per m.g.

Estimates have been made of construction and operating costs for plants of 3 m.g.d. to 100 m.g.d. capacities. The construction costs per m.g.d. vary from $70,300 for a 3 m.g.d. plant to $30,250 for a 100 m.g.d. plant; these figures including excavation, superstructures and all other construction costs, the mechanical and electrical equipment alone costing from $35,433 per m.g.d. for the smallest to $19,570 for the largest. The operating costs per m.g. for these two sizes of plants are estimated as follows: Operators and supervisors, $12.13 and $2.87 respectively; maintenance labor and material $4.60 and $1.82; chemicals, $9.24 in every case; power and illumination, $5.30 and $2.46; steam and gas, $5.57 for the small plant, replaced with $1.92 for fuel in the 100 m.g.d. plant. Adding 8% for interest and amortization, the total costs are $52.24 per m.g. and $24.94 respectively. The chemical costs are based on prices of $9.00 per ton for 66° Be. sulphuric acid, $7.00 a ton for ground lime and $5.75 for salt. The electricity rate is taken at 0.85 cts. per kwh. Salaries used range from $395 a month for the chief operation engineer to $150 a month for helpers.

Rubber Joint for Sewer Pipe

A sewer pipe joint made by using a rubber ring, which is said to have been used in about fifty jobs in England, is described by "The Surveyor." Concrete pipe appears to be used, with specially formed ends. A rubber ring is slipped over the spigot end of a pipe (which has a shoulder 2 inches, more or less, from the end) and this end is then entered into the bell of the next pipe and forced home by pressure exerted by means of a



Rubber ring sewer pipe joint

jack; the space between pipes being less than the normal diameter of the ring, which is consequently deformed.

The joint can be made in a wet trench, even if entirely submerged. It is tight, even if the pipe is moved after laying and even under some pressure, and will, it is believed, remain so indefinitely, retaining its "life" as in the case of flexible joints for steel and iron pipes in this country. It is said not to be affected by the strongest sewage, either acid or alkaline. No figures of cost are given.

Ohio State Highway Department Prepares for Spring Floods

Spring floods in 1933 caused several million dollars of damage to the state roads of Ohio, and while the highway department can not prevent such floods, it believes that provision for emergency service should be made so it can maintain traffic or restore the roads to passable condition as quickly as possible. The department plans to anticipate needs of equipment and facilities in sections of the state where damaging floods commonly occur and division engineers in February were advised to take inventory of equipment and to maintain man power necessary for "quick call", in any flood emergencies.

Getting ready for concreting a Philadelphia street intersection. Maximum speed in completing paving is called for here

Repaving a Heavy Traffic Street in Cold Weather Using High Early Strength Cement

TWO N. R. M. concrete projects were continued during the past winter by the Pennsylvania State Highway Dept. in the City of Philadelphia, one on Chestnut St. between 30th St. and Woodland Ave., the other on Baltimore Ave. between 49th and 52nd St., both on U. S. Route No. 1. Both motor and street car traffic had to be continued during construction, and as detouring these was impracticable, both this and the cold weather construction led to the selection of high early strength concrete. Traffic counts taken on the Chestnut St. project shortly after commencing construction gave a daily average of 47,000 vehicles. Traffic on the Baltimore Ave. job was somewhat less.

The Chestnut Street Job

The Chestnut St. job consisted of replacing an old pavement with a sheet asphalt top and concrete base for 1,609 ft. length and 44 ft. width, including a double car track zone 18 ft. 8 in. wide. In the car track zone the base is 9½ in. and 11½ in. thick; the two thicknesses being due to the two rail heights, 7 and 9 in. respectively. For the remainder of the pavement the base is uniformly 9 in. thick. The wearing surface consists of 1½ in. asphalt on 1 in. binder. The contract for this was let to the Eastern Asphalt Paving Co. for $33,000.

The mix for the base is 1:1.8:3.75; water content 5 gal. per sack of cement. The coarse aggregate is gravel, 40% crushed; this and the fine aggregate being dredged from the Delaware river a few miles above Philadelphia. Typical grading analyses are as follows:

Fine Aggregate		*Coarse Aggregate*	
Passing Screen	*Percent*	*Passing Screen*	*Percent*
No. 50	10.1	⅜"	6.09
No. 20	51.5	⅝"	11.2
No. 4	91.0	1¼"	36.4
⅜"	100.0	2½"	100.0

Four test beams were made up from each day's pour, to determine strength of the concrete and the opening time, two beams in the morning and two in the afternoon. They were protected and cured with the pavement until just before breaking at the testing laboratory which was maintained on the job by the State Highway Department. The following 48-hour beam breaks (modulus of rupture) are typical of the flexural strengths of the concrete obtained in that time:

Test 1	*Test 2*	*Test 3*	*Test 4*
540 lbs.	560 lbs.	540 lbs.	555 lbs.

Average.....548.7 lbs.
(Av. atmospheric temperature during placing and curing of specimens.....45 degrees)

The State specifications permit of laying asphalt when the concrete base develops a beam strength of 500

Preparing subgrade for concrete base

lbs. In the above case, it will be noted, this requirement was met well within 48 hours.

The specifications required that the concrete have a temperature of at least 60 degrees when deposited, and that its temperature must not drop below 50 degrees pending development of the 500 lbs. beam strength. Using high early strength cement, heated aggregates, a flame thrower in the mixer, and prompt protection of the deposited concrete with burlap and straw, the contractor experienced no difficulty in meeting these requirements. He mixed his concrete on the job, using pre-batched, as well as pre-heated, aggregates.

The work got under way November 27th, and, although it has been delayed to some extent chiefly because of the difficulty of tamping ties during wet weather, it will probably be completed before this description is published.

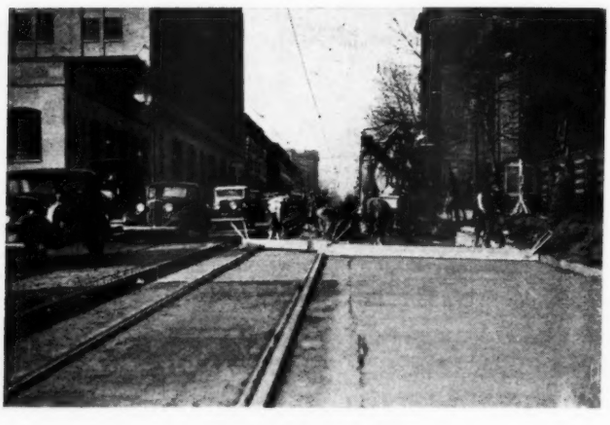
As stated, this is an N.R.M. project, which limits the working hours per man per week to 30. To meet this requirement, the contractor has established a standard day of ten hours and maintains two crews alternately working three days a week. The job has provided employment for approximately one hundred men on the above basis.

The Baltimore Avenue Job

The paving on Baltimore Avenue is confined largely to the double car-track zone. The specifications are practically identical with those of the Chestnut street project. This contract calls for 1,755 lineal feet of concrete base and asphalt top to a width of 18′-8½″; and also, for the same length, two additional 4-foot widths of asphalt for replacing worn-out surfacing on either side of car-track zone, for which no additional base is required. For this job the Union Paving Company, Philadelphia, is the contractor, and their bid price was $20,000.

Using the same brand of high early strength cement as on the Chestnut street job, as well as similar construction methods, similar concrete strengths were obtained and the asphalt surface was laid on the base after the same brief interval following pouring. Also as on Chestnut street, the contractor is mixing his own concrete, using a paver. He is also making use of pre-batched and pre-heated aggregates, although from a different source.

This job was started a few days ahead of the other, but, although smaller, it will take as long or longer to complete, as the paving is confined almost exclusively to the car-track zone, where the delays incident to tamping ties in wet weather have been equally serious.



Laying concrete base

Laying asphalt on concrete base

This project is furnishing employment to about 70 men, working 30 hours a week. Here, too, the standard day is 10 hours, and the men are divided into two crews alternately working three days a week. In addition to the contractors' forces on the two jobs, the street car company had from 20 to 40 men at work almost continuously on the tracks, preparatory to concreting.

Repairs in Place of Patched-Up Jobs

Highway repairs will be made as far as practical with the same materials as comprise the original pavement, according to instructions issued to highway division engineers by O. W. Merrell, state highway director of Ohio.

Disintegration on a brick-on-concrete pavement will be repaired with brick and concrete and a concrete pavement will be repaired with concrete. Pavements are to be repaired rather than patched up.

These regulations, however, will not apply to pavements too old or too far gone for this practice to be economical.

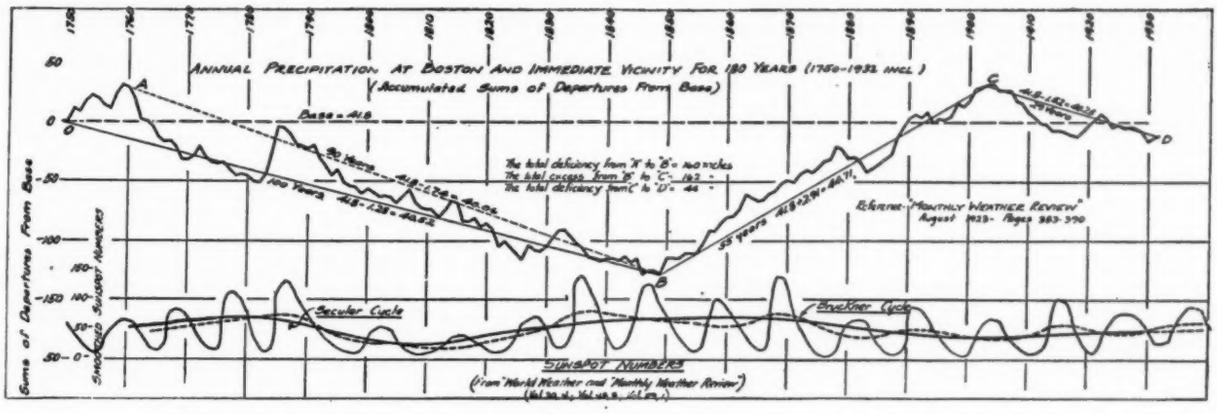
Charles E. McKee, chief engineer of maintenance, pointed out that all too often when a pavement is broken or fails in a few spots instructions are given to a crew to go out and patch up the holes on that piece of road.

"Patching and repairing are two different things. There should be more repair crews and fewer patch crews," McKee said.

"A patch crew is one that goes out and fills up a hole in a pavement with any convenient patching material. The work takes care of the traffic loads satisfactorily for only a time.

"A repair crew when sent out to repair a concrete pavement that is broken in spots removes the old, broken concrete, trims up the edges, places new concrete and properly finishes it. As a result, it is not necessary to soon do the work all over again," McKee concluded.

McKee also cited that a crew may be sent out to fix or patch up old guard rail. The "patch-up" crew merely replaces the broken plank and goes on. A real "repair" gang will see that the posts next to the broken panel are in line, be sure that the new plank is the same size as the rest of the planks, will properly bolt it into place, paint it and take up the slack from the cable.



Annual precipitation at Boston and immediate vicinity for 183 years—1750 to 1932 inclusive

Estimating Run-Off Capacities of Watersheds

TO THE engineers, superintendents and others responsible for furnishing water to a community, the most important feature connected therewith is the quantity of water available from their source of supply. If the quality is not satisfactory it can be made so, but if the quantity delivered is insufficient, this can be remedied (if at all) only by bringing in an additional source, which may require several years of construction.

In the case of surface supplies, the amount yielded by the water-shed, or run-off, varies from day to day, year to year, and decade to decade. By sufficient storage, the average yield (less evaporation and other reservoir losses) can be made available; but to know how much storage is necessary and how large a yield can be relied upon, it is necessary to predict the annual rainfall for many years ahead. The method of doing this has therefore been the subject of much study and research and of many papers and books.

The latest of these, dealing with the southern part of New England only, was a paper by Caleb Mills Saville, manager and chief engineer of the water bureau of the Metropolitan District Commission, Hartford, Conn., read before the New England Water Works Association. It was based upon a study made "to investigate rainfall and run-off conditions on the present and proposed sources of supply to the Hartford Metropolitan District and to ascertain, if possible, their safe capacity during seasons of prolonged drought." The paper is most comprehensive, occupying 86 pages (of which 24 are tables of data). The records studied cover a period of more than 180 years, and the conclusions so carefully arrived at are well worth the most careful consideration. The most important of these are given below, but the entire paper should be studied by those interested.

"The conclusion has been reached as a result of this study that the 20-year period of the Nepaug record is insufficient for the purpose" (stated in the above quotation) "and that a record of at least fifty years ordinarily is required in order to attain that end with a reasonable degree of confidence in the result.

"Periods of drought somewhat more severe than any yet experienced are likely to occur.

"In preparing for the water supply of a large or important community, conditions reasonably certain to occur during a 50-year period, at least, should be provided for.

"A rainfall record, to be of firm value as a criterion, should have extended over a period of at least thirty-five years to be dependable within 2½ percent of normal (plus or minus).

"Run-off records for a period of 20 years can be expected to give dependable results hardly closer than 10 to 15 per cent.

"Run-off from each watershed is so dependent upon topography, meteorology, geology, vegetative requirements, geographical position and local conditions, that the utmost caution should be used in applying data obtained from one watershed to another.

"So far as water supply is concerned, periods of low rainfall of five years or less are of most immediate importance;" but "the longer periods, as the 20-year averages, are of most use in placing a shorter record in its relative position in the historical sequence."

"The writer is of the opinion that in the hands of an experienced water-supply engineer reliable rainfall records are much better indices of capacity of a watershed than are run-off records of less than 25 or 30 years, and that the amount of rainfall during the lowest three or four consecutive years, modified by proper factors to express run-off relationship, is a much safer criterion for estimation of watershed capacity on an unknown area than are run-off records from other streams."

From study of the records and experiences during the drought period of 1920-1932, "it seems to the writer to be desirable that provisions for at least fifty years in the future be considered as a reasonable minimum limit for water supply development.

"It is exceedingly doubtful if any record ordinarily extant has included such drought periods as are liable to come at any time."

Long-period records seem to show a tendency to a general decline for a few decades followed by a period of increasing rainfall. This is shown by the curve of annual precipitation at Boston and vicinity for 183 years. From 1750 to 1850 there was a general fall, for the next 54 years a rise, and "the position of the period since 1904 is plainly on the downward path of rainfall."

"A little consideration of the matter of meteorological

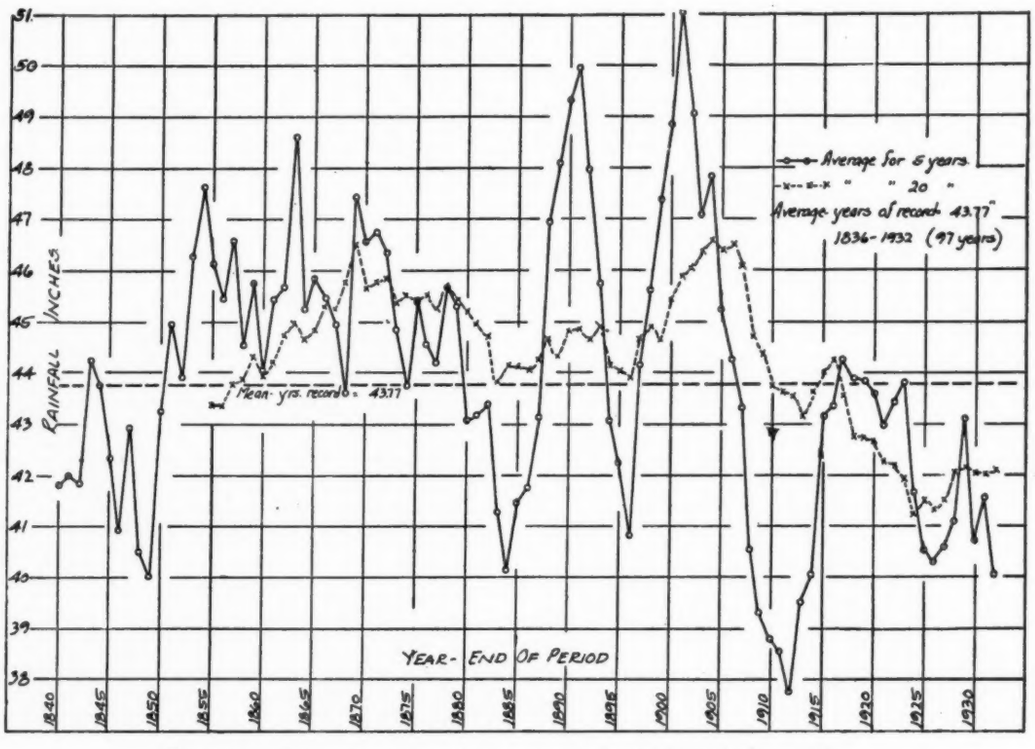
and hydrological occurrence, even without complete acceptance of the more advanced thought of correlations with solar phenomena, may result in more reliable solution of problems which are of importance to the safety and welfare of many people. The experience of the past is the most reliable guide for the future, but in order to use that experience safely it is necessary to use *all* of the facts which the past has provided.

"In any study of rainfall over long periods two outstanding facts are evident: (1) That there are periodic waves in the record during which the general average is decreasing to a minimum and thereafter increasing to a maximum with evident tendency to again show decrease as the future unrolls. (2) Accompanying these long-period swings are other oscillations of more or less amplitude, corresponding somewhat to the so-called 'seiches' in large lakes and the oceans, where for several years there will be either excess or deficiency of rainfall, although the general tendency has a distinct upward or downward trend. These latter fluctuations are those most significant in water-supply work, but position on the long-time record of a station is a most important factor in effectively determining the safe probable yield of a watershed.

"The relationship between rainfall and run-off seems to have too many complexities at the present time to attempt a general correlation formula, although it seems probable that, by study of individual watersheds, it may be possible in time to arrive at some general laws that will be applicable." In studying this relationship, it is necessary to consider monthly rainfalls and these fluctuate around the monthly normals much more than in the case of annual amounts. "A considerably longer period, therefore, possibly one hundred years, is necessary in order to fix monthly average values within small limits."

Survey of Winery Wastes

The Bureau of Sanitary Engineering of California has completed a survey of waste disposal practices in sixty-six wineries of the state. This survey has been in progress during the past three months. The impetus given to the industry since the repeal of the 18th amendment has developed acute problems in the disposal of winery wastes. In those wineries which produce only dry wines of low alcoholic content the problems of waste disposal are less acute than in those wineries which make fortified, or sweet wines. In the case of wineries producing dry wines of low alcoholic content, the wastes are: *pomace*, a garbage-like sour waste made up of stems, skins and seeds; *lees*, the organic and tartaric sediment of fermentation amounting to 2 or 3 per cent of the wine; and the dilute wash-up water. Lees are strongly organic, but are fairly easily handled on drying ground. Altogether, wineries making dry wine have little trouble with waste disposal on land. Fortified or sweet wine wineries, however, must carry on a distillation of part of the dry wine to produce the alcohol for fortification and in addition to the above wastes, produce "still slops." The "still slops" are highly concentrated and cause much nuisance. If emptied into streams, fungus-like growths resembling sheep's tails form on the submerged branches of trees and vegetation. Land disposal is used successfully only if soil is deep and loose and the neighborhood is sparsely settled. When these advantages do not exist a serious problem prevails for which no present remedy is seen. On the basis of city sewage, the lees from one ton of grapes are equivalent to the organic waste of 35 persons; the "still slops," to 250 persons, according to studies made to date. A winery may handle up to 100 tons per day. Hence, the problem is apparent.



Five-year and twenty-year running averages of rainfall at Amherst, Mass.

A Digest of the Sewerage Literature of the Month giving the main features of all the important articles published during January

The Digestion Tank

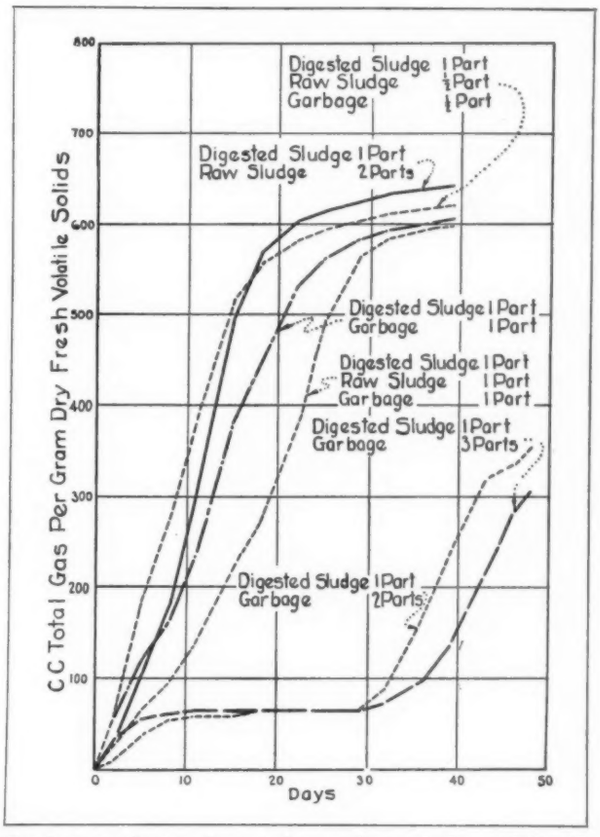
SOME Treatment Plant Details at Meadville, Pa., are of interest. "Sludge pumps, hot water pumps, heating boilers and gas meters have been placed in the water-tight basement of the control building and a color scheme has been adopted for various types of piping and equipment throughout the plant" and a piping plan of the plant showing the color scheme hangs in the office. (A color scheme is used for piping in the Joint Meeting Sewage Treatment Plant[6] lending "an artistic touch to the piping layout.")

Each influent channel to the settling tanks has a perforated air line laid in the bottom supplied with air under 1 lb. pressure, used several times a day to keep the channel clean.

A covered cylindrical steel tank with conical bottom, capacity 150% of one day's accumulation of fresh sludge, is "one of the most useful parts of the plant." As a concentration tank, fresh sludge is pumped into it, lime being circulated in it, and surplus water decanted through openings set 9 in. apart in elevation from top to bottom. It measures, by positive displacement, the amount of sludge pumped each day. Also cloudy supernatant from digesters was run into it and partly digested sludge settled rapidly and was returned to digesters.

Lima, Ohio, Sewage Treatment plant was operated up to design capacity from the start and excess flow by-passed to the river.[5] The treatment consists of primary settling, activated sludge treatment, sludge digestion and drying on glass-covered beds; but during January, February and March of 1933 the aeration units were taken out of service because of the increased flow of the Ottawa river and the saving of $3500 in power cost, with current purchased at 1 ct. per kwh. The daily flow for the year averaged 5.41 m.g.d. The 5-day B.O.D. was reduced from 149 ppm. in the crude sewage to 9 ppm. in the aerated effluent and 106 in double settled but unaerated. The plant was operated by a superintendent, laboratory assistant, 3 operators and 3 assistant operators; which force also operated and maintained 3 sewage pumping stations, one ejector station and 9 regulator chambers on the intercepting sewers. The actual cost of operating the treatment plant was $18,925; $12.34 per m.g. for complete treatment and $6.02 without aeration. The cost is met by sewer rentals, 80 cts. minimum for 500 cu. ft. or less per quarter, 15 cts. per 1,000 cu. ft. additional.

The automatically controlled bar *screen* has been in continuous service and "required very little attention." The screenings *incinerator* is run continually, using digester gas. At first skimmings from primary tanks were burned, but contained so much oil and grease that the incinerator chimney was cracked badly by the high temperature; skimmings are now burned in the open. The *grit collecting* unit "has worked very satisfactorily," giving grit "noticeably free from organic material." The *primary tanks*, with traction clarifiers, gave trouble at first by underspeed alarms failing to function properly, but those of a later design replacing these have given no trouble. During the early months of operation, when the digestion tanks foamed badly, the supernatant liquor returned to the primary tanks was almost as heavy as sludge, and was discharged on a field until foaming ceased. The diaphragm *pumps* used for raw and excess activated sludge "caused a great deal of trouble for several months due to the failure of diaphragms, rubber seats and valves," which lost their life and became swollen. Then bronze seats were placed in all valve chambers and lead-impregnated rubber balls replaced the original ball valves, and no further trouble has been experienced, except for matches, etc., lodging on the valve seats, which has been helped by increasing the pump stroke. One of the four *aeration tanks* at first required ½ to ¾ lb. more pressure than the others. This was remedied by emptying, applying a 5% solution of lye and allowing this to filter through the aeration plates into the containers, applying air and thus forcing it back through the containers and repeating this daily for ten days. In the *digesters* the stirring mechanisms are run continuously. Thick scum forms



Total gas production from garbage and raw sludge seeded with digested sludge. Incubation temperature 28°C.

under the roof and is not removed. The sampling manholes are no longer used since gas in them led to the death of two men. *Sludge* dries in about 20 days and is in great demand as fertilizer.

Digesting Garbage with Sewage Sludge is thought by Keefer and Kratz[3] to have numerous possibilities, judging from experiments conducted in Baltimore; which however did not include financial considerations except indirectly. "Even though the process is not adopted as a permanent method of treatment, it offers a means of garbage disposal for short periods of time, especially during the summer months, when the garbage plant is frequently overloaded and when the sewage works usually operates most efficiently due to warmer temperatures."

As to procedure, they suggest grinding the garbage at the sewage works and mixing it with the raw sludge as it is added to the digested sludge in the digestion tank; or grinding it at several stations and discharging it into trunk sewers; or having a grinding machine in each dwelling, the ground garbage to be discharged into the sewer, which would eliminate garbage collection.

This method would necessitate additional digestion tank and sludge drying capacity. The amount of dry solids in Baltimore's garbage is practically the same as the dry solids in the sludge removed from the preliminary settling tanks, but "nothing is known as to what extent the ground garbage would increase the soluble material in the sewage, which would not be removed by sedimentation." Their experiments indicated that garbage digests readily if seeded with at least an equal volume (dry volatile solids basis) of digested sludge, with or without raw sludge, giving complete digestion in 30 to 40 days at 28°C, the optimum pH being 6.8 to 7.2; the methane production varying from 300 to 400 cc. per gram of dry fresh volatile solids, and total gas 600 to 700 cc. The digested material is free from offensive odor and can be dried on sand beds.

Following these experiments, the city installed a garbage grinding plant with a capacity of 20 tons an hour[27] and between Aug. 12 and Sept. 27 (the peak of garbage collection) ground 70 tons of garbage daily. It required 4.35 kwh. to grind one ton and 4 to 6 men to feed the grinder. No trouble was experienced except with corn husks. The garbage solids practically equalled those of the sewage, but "as indicated by chemical analyses, the garbage did not increase the strength of the effluent" from the primary settling tanks, but there was appreciably more scum formation, and the operation of the trickling filters, humus tanks, digestion tanks and sludge beds was not at all affected. Garbage increased the B.O.D. of the sewage 10.7% in 5-day incubation but would probably increase it much more in 40 or 50 days. Continued addition of ground garbage would undoubtedly necessitate larger digestion tank and drying facilities. How it would affect an activated sludge plant is not known.

Variation of rate of ***sludge digestion*** with ***temperature*** were studied by Fair and Moore[1], summarizing all available information on the subject. Rate of digestion "is controlled by many variables, chief of which are the nature (biological as well as chemical) of the seeding material, and the nature of the material to be digested." The authors, therefore, endeavor to compare different results by "expressing the times at various temperatures in terms of the time at some standard temperature," using 25°C as the reference point. They reached the following tentative conclusions:

1. With regard to the effect of temperature on batch digestion of sewage solids, three or possibly four distinct zones of activity seem to be indicated as follows:
   (1) Thermophilic zone—above 42°C.
   (2) Intermediate zone—28° to 42°C.
   (3) Temperate zone—below 28°C. and possibly above 10°C.
   (4) Cryophilic zone (possibly)—below 10°C.
2. In two of these zones (1 and 3) and a possible third (4), the digestion process seems to follow ordinary chemical laws, the time decreasing and the rate increasing as demanded by the law of Arrhenius.
3. In the intermediate zone (2), chemical laws are apparently not allowed, and there is some evidence of a disturbing factor, possibly the unfavorableness of these temperatures to the bacteria themselves.
4. In agreement with Heukelekian, the optimum for non-thermophilic digestion is set tentatively at about 33°C., although in this region differences of a few degrees produce but little change in digestion time.
5. The behavior of activated sludge may not be in all ways similar to that of plain-sedimentation solids.

Digestion Gas resulting from anaerobic digestion of sewage exceeds in weight the weight of volatile matter removed.[2] Fats and soaps such as are found in sewage yield 1.50 to 1.55 grams of gas per gram of material decomposed. Considering all volatile matter, the gas yield is about 1.44 grams of gas per gram of organic matter decomposed, including 0.11 gram of CO_2 held in solution in the liquor. "The average weight of gas *collectable* per pound of volatile matter digested is probably about 1.2 pounds." In the study from which these figures were derived the carbon balance error was reduced to less than 7%, the nitrogen balance error to 3.7% or less, and the ash balance error of 3.1% or less.

Trickling Filter Media tend to disintegrate in northern climates by alternate freezing and thawing. This tendency in different materials is commonly compared by soaking them in sodium sulphate. However, alternate freezing and thawing, using artificial refrigeration, is considered by Prof. Payrow[28] to be "not only conclusive and closest to actual conditions but the most convenient and probably the most economical for routine testing purposes." He tested limestone and blast furnace slag by both methods, using for freezing a commercial electric ice freezer cabinet, with trays as shallow as possible and with a tubular heating element in each to thaw the specimens. With this, a 100-cycle soundness test can be completed in slightly more than a month. As a result he concluded that, of four limestone materials tested, two "unquestionably must be rejected for filter media," while the other two (dolomite limestone) are very acceptable. Of two slag samples, one might be questionable but the other is very acceptable.

Sludge Beds of Anthracite Coal have been tried at State College, Pennsylvania. To date five runs have been made and the coal gives quicker dewatering than does sand, while giving as satisfactory an effluent. The coal has an effective size of 0.37 m.m. and a uniformity coefficient of 2.89, while the same figures for the sand are 0.26 m.m. and 2.00. The void space of the coal is 40.5% while that for the sand is 37.5%, thus accounting for the difference in the rate of filtration. Both materials are priced the same per unit of volume."

(Continued on page 45)

The Editor's Page

Appraising as An Aid in Editing

Every business worthy of its name in the manufacturing and distributing fields takes an annual inventory of its physical and financial assets. Presumably every magazine does the same. But PUBLIC WORKS goes further than this, and at least once a year makes an appraisal of its policies, and of the wants of its readers and the needs of the industry, to enable it more surely to adjust the former to the latter, rather than follow the easy course of continuing in the routine of two or three decades ago in spite of the tremendous developments and changes that have taken place since then.

In making this appraisal of satisfaction rendered, we send thousands of questionnaires to our subscribers. Of those sent out this year, 433 had been returned by city engineers alone when we began tabulating the replies (more are still coming in by every mail); which, as they come from all sizes of cities and sections of the country, would seem to give a fairly good idea of the reaction of this class. In these we note several changes from past years in needs and wishes and shall modify our program in accordance therewith during the next few months.

In asking our readers for their criticisms, we specially requested their opinion of the value of the WATER WHEEL and the DIGESTION TANK, two features of this magazine which are designed to serve the busy engineer. The replies seem to show that we are justified in continuing them.

Regarding the WATER WHEEL, of the 433 city engineers returning questionnaires, 146 did not answer this question, 257 reported that they used this information consistently and 30 stated that they did not use it. Why only 60 per cent replied favorably seemed to call for further investigation of the replies and functions of the other 40%. This investigation disclosed the following: Of the 30 who did not use it, 16 said that the water supply of the city was under the direction of another man; in 9 of the cities the water plant was privately owned. There were no data on the remaining 5. Of the 146 who did not answer the question, 63% stated that the water supply was under the direction of another man; 23% reported their cities were served by private water supplies; and 14% gave no data which furnished an explanation.

In regard to the DIGESTION TANK, 206 of the 433 city engineers reported that they used it regularly; 7 reported they did not use it; 220 did not answer the question. Further investigation showed that 60% of the 227 had no sewage treatment plants, generally because dilution was employed as final treatment; in 15% of the places, sewage treatment was in charge of someone else; the remaining 25% either gave no data, used outside plants, or just didn't read it.

In addition to these questions, we asked what subjects the several readers would like to have discussed this year, and about 70 per cent took the trouble to indicate their desires. These were too numerous to endeavor to name here, but will be used as a guide, during the coming year, in our selection of articles. We certainly appreciate the interest our subscribers have taken in cooperating with us to the end that every page of PUBLIC WORKS may be of the greatest possible interest and value to them.

Aid Through Public Works Is to Be Not Only Continued But Even Expanded

This is apparently insured by the certainty that PWA work will increase as rapidly as the weather permits, and also by the program just announced by the President for continuing relief of unemployment during the next twelve months.

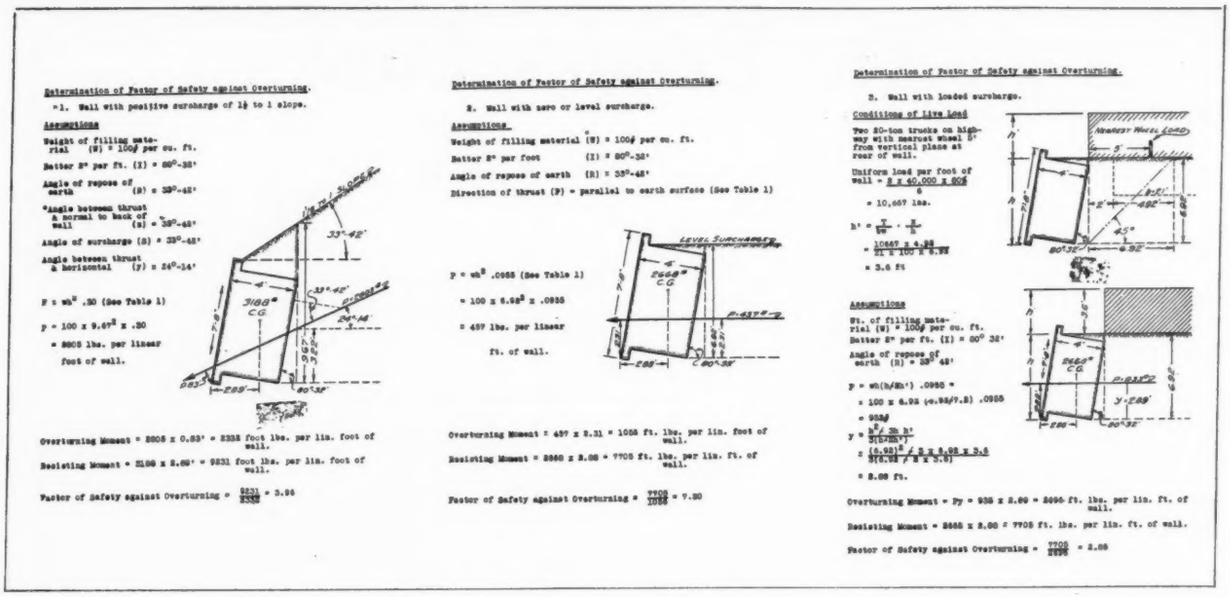
Returning from a personal survey extending from coast to coast, deputy administrator Henry M. Waite reported on March 5th that "almost everywhere the PWA engineers reported that they had so many projects in construction or with construction contracts being let that they could not get inspectors on the job fast enough to cover the projects." Contracts have been sent out covering 80 per cent of the non-Federal allotments, and more are being let every day, and "most projects which have received allotments will be under construction as soon as weather permits." Those that are not, will have their allotments cancelled and given to others.

Under the President's program for the ensuing year, the unemployed in large cities are to be employed on "work programs which would not normally be undertaken by public bodies, but which are at the same time outside of the field of private industry. Industrial workers who are unemployed and in need of relief should be given an opportunity for livelihood by the prosecution of a flexible program of public works."

The public works used as the medium for unemployment relief should be planned by city and county engineers, and those who have not already done so should give the matter their immediate and careful consideration, preparing well worked out plans ready for instant use and adequate to utilize all the able-bodied unemployed in their communities.

A number of cities last summer and fall presented for PWA approval half-baked projects which they would now like to withdraw, recognizing that they were poorly planned. "This discovery" says Col. Waite "has brought localities to a realization of the need for long-range planning of coordinated public works programs." For more than a year PUBLIC WORKS has been urging such planning to meet just the emergency that presented itself last summer and will do so again in a few weeks.

A wise, comprehensive planning providing for coordinated projects which will all be of public benefit and will include a sufficient number which fit in with the President's program as stated above, is a large order, but we know our city engineers can fill it if they will. Failure to do so will delay recovery through public works.



Figs. 1, 2 and 3, showing typical solutions

Crib Retaining Walls

In the August and November issues of PUBLIC WORKS *were published articles covering briefly the designing of gravity and reinforced concrete retaining walls. In this article the crib type of retaining wall will be discussed. In a later series of articles, the designing of various types of retaining walls will be treated in considerably greater detail.*

IN addition to the gravity section wall and the reinforced concrete wall, the crib type of retaining wall is quite widely used. In its simplest form, this may consist of discarded railway ties or other timbers laid up in crib form; pre-cast concrete members, with various interlocking devices, have been quite generally used; and metal crib walls have recently come into general use because of their advantages.

The crib type of wall has among its advantages the facts that erection can be carried on rapidly, without regard to extreme cold, and with a minimum of equipment and tools; also, increase or reduction in height, and even salvage of the sections is possible.

Essentially, this type of wall consists of a series of interlocking bins, which may be filled with earth, rock, or other available material. The weight of the bins and the filling in them oppose the sliding and overturning moments of the earth retained behind the wall.

In a crib wall, the members and the joints must be designed to withstand certain forces. These are: 1. Compression, or the force tending to crush the members, especially the joints. Naturally, this is greatest at the bottom, where the loads from above are concentrated. 2. Tension, tending to pull the members apart, either by pushing forward on the wall or by sideways motion, due perhaps to unequal settlement. 3. Shear, or the force acting to push the stretcher forward and tending to shear its connection with the header. This force is usually considered to be greatest on the bottom units in the rear of the wall.

The amount of these forces will depend upon many factors, such as the angle of repose of the material, its weight, foundation factors, etc. They cannot well be evaluated in advance. Consequently, a material should be used having an ample margin of safety, with joints possessing considerable resistance to crushing and pulling apart.

(Continued on page 44)

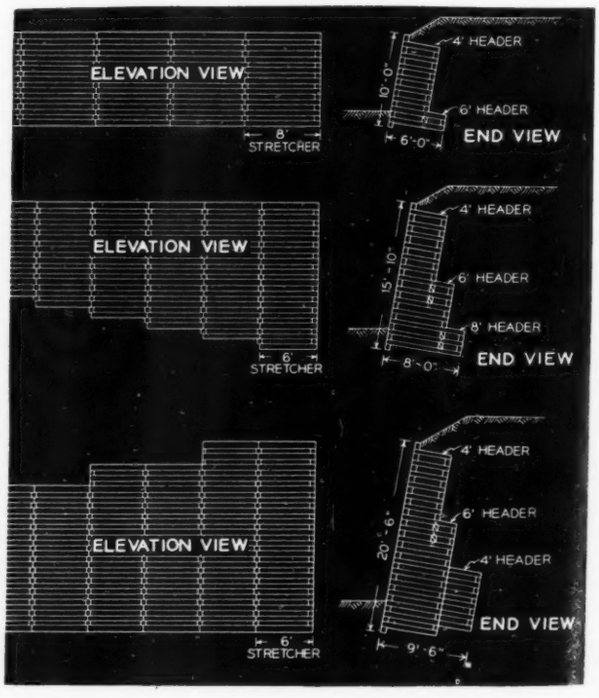


Fig. 4. Typical crib retaining wall designs

Low-cost road construction

Pressure distributor applying Texaco Cutback Asphalt during construction of Road-Mix type of Low-cost surface on State Highway No. 168 between Crab Orchard and Stanford, Ky.

This method of machine-mixing insures a uniform coating of the stone with the asphaltic material.

When the mineral aggregate and Texaco Cutback Asphalt had been thoroughly mixed, the surface was compacted by roller.

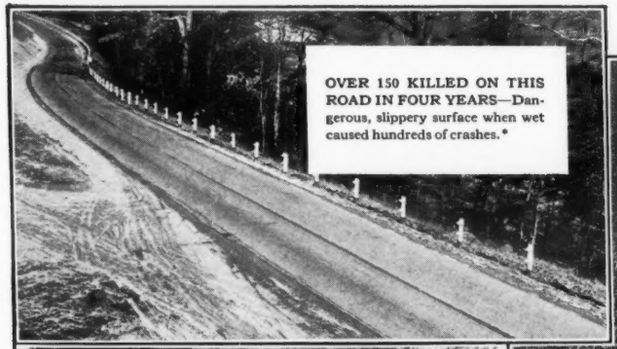
A tough, non-skid, waterproof surface is the result, adequate for moderately heavy traffic and attractively low in cost.

The Texas Company, Asphalt Sales Dept., 135 E. 42nd St., New York City

FOR SKID-PROOF ROADS

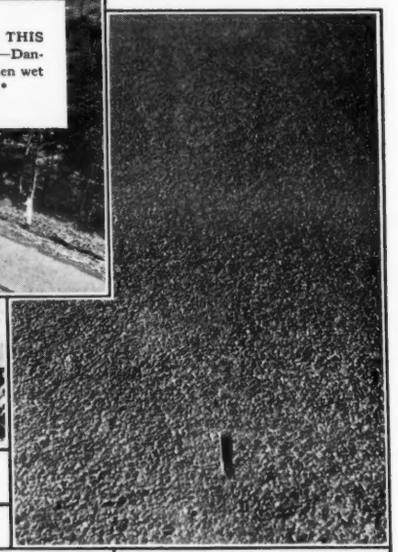
RELY ON TAR.....FOR BETTER ROAD TAR, RELY ON

KOPPERS Tarmac

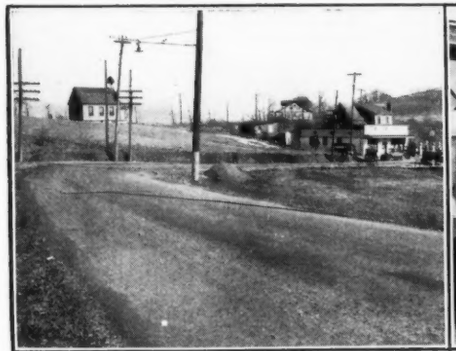


OVER 150 KILLED ON THIS ROAD IN FOUR YEARS—Dangerous, slippery surface when wet caused hundreds of crashes.*

AS HIGH AS 7 WRECKS A DAY TOWED INTO THIS GARAGE—Familiar scene along the highway pictured in the upper photo.



NOT ONE WRECK SINCE THIS TARMAC SURFACE WAS APPLIED—The granular texture of this Tarmac surface shows why it ended the skidding hazard on the road shown in the upper left.



AS MANY AS 3 WRECKS AN HOUR ON THIS CORNER BEFORE TARMAC WAS APPLIED—Photo shows Tarmac applied to curves on Saltsburg Road. Norwood Richmond, of the Richmond Garage (shown in upper right hand corner) said: "Before Tarmac was applied to these curves, this was the slipperiest road in this section of the country. Every rain meant wrecks."

BUS DRIVER KNOWS—Floyd L. Hughes, master driver for Northland Greyhound Buses, wrote "I find the Tarmac surfaces are non-skid . . . even on the considerable grades in La Crosse County (Wisconsin)."

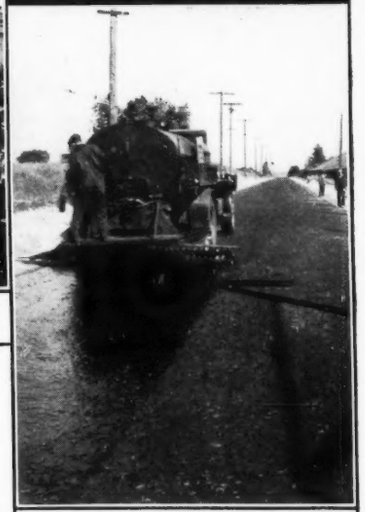
*(Location on request).

Crude coke-oven tar is produced by carbonizing bituminous coal in coke ovens. The Koppers Company has had more to do with the development of the modern coke oven than any other organization in America. It has built more than 75% of all the ovens now in existence in this country. It is constantly conducting research work to improve tar producing and refining processes.

Is it any wonder that we can safely advertise: "For better road tar, rely on Koppers"?

THE COMPANY WHICH BUILDS THE HUGE COKE OVENS THAT PRODUCE MODERN COAL TARS IS NATURALLY IN THE BEST POSITION TO PRODUCE BETTER TARS FOR ROAD WORK

The plant of the Philadelphia Coke Company, one of the great batteries of ovens built by the parent company of the Tarmac organization.



Applying Tarmac as a seal coat on Johnson Boulevard, Montgomery County, Penna.

KOPPERS Tarmac

KOPPERS PRODUCTS COMPANY

KOPPERS BUILDING, PITTSBURGH, PA.

Other Products: Creosote—Roofing—Waterproofing
Dampproofing—Traffic Paints—Tar Paints

Do you make regular use of the Readers' Service Dept.?—see pp. 34, 52, 53

Developments in Low-Cost Road Construction

Some high spots in the trends of Low-Cost Road Construction and Maintenance are reviewed briefly in this article, which introduces* PUBLIC WORKS' *1934 series on this subject

This hot asphalt treatment on limerock base cost $5,000 per mile

"THE highway engineer today must appreciate that the vast sums of money formerly appropriated for the higher types of road construction will not be available this year, nor for some years to come, owing to the bonded indebtedness incurred by the various municipalities for relief purposes. . . . He will necessarily have to lay aside much of the experience he has gained through the past twenty years, and resort to some theory and much common sense to develop a program that will use the maximum of local labor and the minimum of foreign materials. He must so build his projects that the public can see for themselves that their money is being expended in a useful way, not only taking care of unemployment, but also developing a foundation with an alignment and grade that can be utilized for higher types of construction in the future."

The above statement by R. B. Traver, engineer of Onondaga County, N. Y., covers essentially the problem facing the highway engineer today. How he has handled the situation in Onondaga County has been told in PUBLIC WORKS already, [1] and another article in this issue brings this up to date.[2]

A corollary is the increasing general recognition that the construction of low-cost roads requires a high degree of engineering skill and that the basic elements in design and construction—alignment, drainage, subgrades, and width—are as important in a low-cost as in a high-cost road. A sounder recognition of actual traffic needs has been developed. It is doubtful if, even in the face of greatly expanding sales by automobile makers, the volume of traffic on our roads will greatly increase in the near future. Most of these sales appear to represent replacements, and for the traffic expected, lower-cost types will doubtless prove adequate. Therefore, even with lowered revenues, it will be possible to carry on a very large highway program.

Improving a Minnesota road by spreading crushed rock

Force Account Construction

There appears to be a growing realization of the place of force account construction in the low-cost road field. There are a number of reasons for this. In the case of contract construction, a very considerable expenditure is required for surveys prior to placing a contract—probably in excess of $100 a mile, even in these days of low salaries for engineers. When to this is added the office and other work preparatory to letting the contract, the expenditure for engineering is out of proportion to the cost of the road.

In another article in this issue[3] is brought out the lack of proper specifications for low-cost road construction. Contractors are loath to bid where specifications are not full and clear, and, although considerable low-cost road work has been done by contract, much has been and is being done by force account work satisfactorily and economically. A. J. Runnals, in this issue[4], brings out some pertinent arguments for force account construction.

If the city or county or state has equipment suitable for construction and maintenance operations, it is much more likely that work will be done than if it is let by contract. (Pacificists say that the existence of a standing army constitutes an invitation to go to war, because we like to use the tools we have.) Without doubt, when construction equipment is available, when men need work, and when local materials can be used for most of the work, there remaining to be purchased only a relatively small amount of asphalt, tar or calcium chloride, work is very likely to go on, since the direct expenditures, aside from labor, are small.

Low-cost road jobs usually are small individually. Any contract, in the East especially, that aggregates more than $25,000 is a large one and the average is much smaller. On work such as this, force account construction is economical.

Construction Equipment

There has been a marked tendency toward the utmost utilization of hand labor during the past year, but as G. D. Macy, New Mexico State Highway Engineer,

Mixing and rolling Retread

says[5]: "Under our modern road building methods, it is almost an impossibility to perform all necessary work with teams and manpower. . . . Nearly all delays in getting day labor projects under way were due to inability to get sufficient equipment rapidly enough." Reports from nearly 1,000 cities and counties[6] indicate that many engineers believe that an equivalent amount of labor could be employed, and more work done for the same expenditure, in many cases and on many types of work, if more freedom were permitted in the use of machinery. Probably nearly all will agree that the work would also be done better.

Many new pieces of equipment have been placed on the market during the past year which are designed for better low-cost road construction. These have been described[7] from time to time. Machines designed to give smoother riding surfaces, to produce better mixing of bituminous roads, both plant and road-mixed, and more efficient power units have been most prominent.

Because of the light buying during the past two or three years, the great increase in highway construction during the past year, the heavy work of snow removal which broke down many pieces of equipment already well worn and the continuing construction program for the coming months, cities and counties will probably find it necessary to purchase such equipment in greater volume during the coming year, despite the reductions in budgets. Sales records in these fields during 1933 surprised many manufacturers, and they will probably be better in 1934.

Highway Stabilization

Undoubtedly the most outstanding development in highway engineering practice during the past year was the development of soil stabilization practice, whereby, through the combination of soils having varying characteristics, a firm and stable road surface is obtained. In this method, clay is incorporated in existing sand or gravel by scarifying, pulverizing and mixing; and after shaping and dampening, a relatively small amount of calcium chloride is added. For a road in Michigan[8] the total cost for such work amounted to 3.6c per square yard or $381 per mile, including rental for the equipment used. Similar work has been done in Onondaga County, N. Y., where a tremendous unemployment relief program has been most ably tied in with stabilization work, giving that county farm-to-market roads reaching into the most remote sections.

Not only do such types provide a satisfactory road surface for present use, but as traffic increases, surface treatments, or mixed-in-place, retread, concrete or other pavements can be placed on them at a relatively small expenditure.

Developments in the Use of Tar and Asphalt

Methods of utilizing local aggregates and bituminous products with surprising economy have been worked out in many parts of the country. No new methods of construction have been developed, but the emphasis has been rather on the improvement of existing methods. Changes have been gradual, rather than sudden and dramatic. Considerable progress has been made in obtaining smooth-riding surfaces, so that low-cost roads can satisfy fully public demand in this regard.

Studies have been made of the bitumen content of road surfaces, and of the amount of bitumen required for best results. Generally, it has been found that too much bitumen has been used, except in the surface layer of the pavement, where there is often too little for best results.

Developments in the use of asphalt for highway construction and maintenance were ably covered by Bernard E. Gray, highway engineer of the Asphalt Institute, in a paper presented at the annual meeting of the Association of Highway Officials of the North Atlantic States last month. A similar paper was presented covering developments in the use of tar by George E. Martin, consulting engineer, General Tarvia Department, The Barrett Co. Abstracts of these papers are herewith presented.

Developments and Present-day Practices in the Use of Tar

By George E. Martin

A NEW grade has been added to the cold surface treatment bitumens (those that can be removed from the tank car without being heated, although they must be warmed for use on the road) which has an Engler specific viscosity at 50°C. of 26 to 36. It was developed as a "re-tread" binder but has proved very successful as a surface treating material, chiefly in re-treating bituminous surfaces and in surface treatment of concrete and brick. It produces a somewhat heavier and tougher surface than the lighter cold surface treatment materials and, although it sets more quickly, can be dragged like them.

There has been a steady increase in the dragging of surface treatments, which distributes the tar over the surfaces of the covering aggregate and produces a smoother riding surface. All cold surface treatment tars and "re-tread" binders can be dragged, but the hot ones can not and should be broomed or broom-dragged and rolled.

Non-skid surfaces can be produced by use of surface treatment tars. For this, a sandpaper-like surface may be more satisfactory than a large exposed aggregate since tires cling to it better; for many years Connecticut has used a sand cover with satisfactory results.

A demand for methods and materials for finishing

1. Public Works, April, 1933.
2. See this issue, page 32.
3. See next page.
4. See page 35.
5. New Mexico Highway Magazine, February, 1934.
6. Now being tabulated in this office.
7. See "New Equipment" sections of Public Works.
8. Public Works, December, 1933, and January, 1934.

more quickly the re-tread or mixed in place type of surface has been met by the development of heavier tars, present practice being to use those with Engler viscosity at 50°C. of 26 to 36 for summer work and of 16 to 22 for the cooler seasons; all of the binder being sprayed in one application and the seal coat in two applications.

In this type of construction, all of the stone to be used is spread along one side of the road, sprayed with tar (1½ gal. per square yard for a 5-inch depth), turned over a few times, spread over the road surface, and rolled. During rolling, small-size stone chips are swept into the voids, which must be thoroughly and uniformly filled. A first seal coat is applied, using about ¼ gal. per square yard of the same grade of tar used for the mixing, covered, swept and rolled; followed by a second coat of the same material similarly applied. The amount of tar required per square yard is therefore: mixing, ¾ gal.; first and second seal coats, each ¼ gal.; total 1¼ gal.

Plant Mixes

Use of plant-mixed paving materials removes part of the responsibility from the highway official to the manufacturer, simplifies construction operations, and the grading of bitumen and aggregates is better and more uniform.

Plant mixes using tar binders have been of the hot-mix, cold-laid variety, usually produced to meet definite specifications. In these mixes there has been a tendency to require a somewhat smaller aggregate, producing a tighter, more thoroughly filled surface; except that in New England the engineers desire an open, rough-textured surface.

Practically all mixed material is hauled from plant to job in trucks; car shipments are the exception rather than the rule.

Winter Work

Not so long ago all road work, except in the extreme southern states, stopped during the winter months, but during the past year there has been a demand for continuing public works in the winter, when the unemployment situation is most critical. Tar was used every month during the winter of 1932-1933. As a general proposition, liquid tars can be applied successfully when the road is damp, but not wet. Covering and rolling must follow closely behind the application of the tar. Plant-mixed tar concrete can very readily be handled during the winter.

Constructing a tar-gravel road. Mixing and applying Tarvia

Applying bitumen on a penetration macadam

Fundamental Construction Principles

In endeavoring to build more miles of low-cost roads cheaply and finished immediately, there has been a tendency to overlook some fundamental principles of successful work. One is that sufficient bitumen must be retained in the top inch of the road to hold it together, which requires that the base be thoroughly filled before the top is applied so that the top bitumen can not run down into it.

If too much cover is used, the loose material, under the action of traffic, grinds away the surface and causes it to disintegrate. The remedy is to use less cover; if more is needed it can be added later. A good rule for broken stone cover on a tight surface is 10 lb. for each 0.1 gal. of tar. One-size cover tends to aggravate this condition; a reasonable gradation of sizes from bottom to top is desirable.

Excessive dragging may cause difficulty; thorough mixing of all the stone cover is not necessary—a smoothing rather than mixing action is needed.

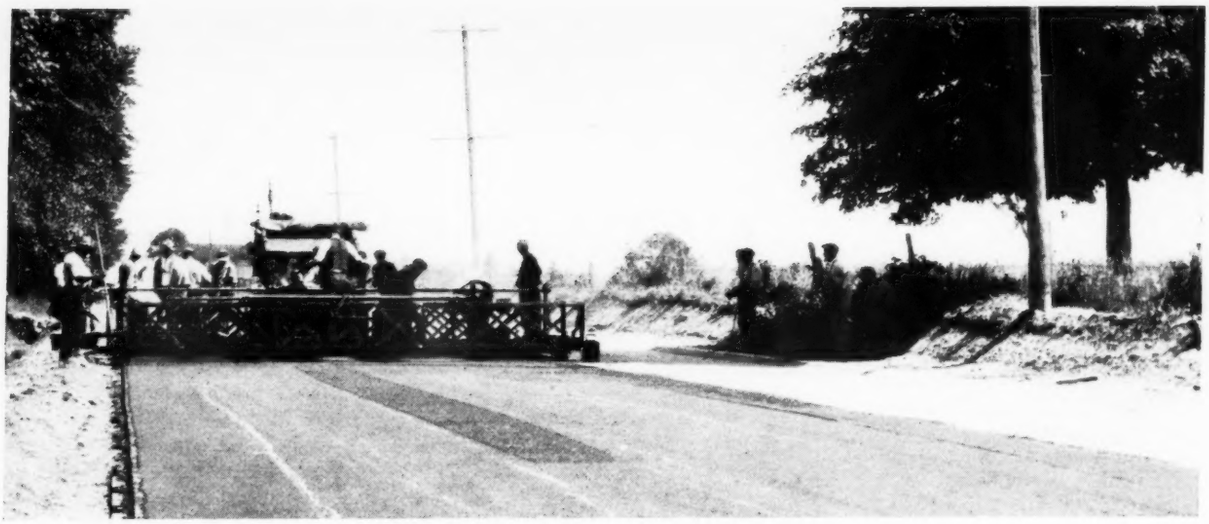
Although both tars and asphalts are black and sticky and are used for many similar purposes, they do not always act the same under similar conditions. Tars are heavier than asphalts and, because of this and also of their natural penetrating qualities, tend to work down into the road crust. If not permitted to go too far this has the advantage of forming a strong crust; but to hold sufficient tar at the surface, this should be thoroughly filled before the tar is applied.

Smaller aggregate, better graded, and tightly filled tops will produce better tar surfaces at less cost for both construction and maintenance.

Developments in Use of Asphaltic Materials

By Bernard E. Gray

ASPHALT products have been developed for every class of aggregate and for all kinds of both road and plant manipulation, but it is important to have aggregate and asphalt combined in the correct proportion. Much recent information on this subject has not yet been fully incorporated in construction specifications. For either simple surface treatment or hot-mix pavement, the purpose is essentially the same, viz. to introduce the most effective amount of asphalt cement of



All pre-mixed pavements should have mechanical finishing

the proper consistency into a given amount of aggregate of the proper size.

Of the errors in using asphaltic products, probably the greatest is the use of too much asphalt per unit of aggregate. If an aggregate is coated with such an amount of bituminous material that the surface can immediately be covered without much manipulation, there will be a surplus which will drain off when the aggregate is spread. If the mix itself be somewhat lean, it is always easy to place a very thin seal coat which is sufficiently rich, and the surface will not shove if it is properly proportioned.

Both construction and maintenance costs are often unnecessarily high because too much bituminous material is used. For surface re-treatment, the standard practice in many places is ¼ gal. per sq. yd., whereas 0.1 gal. frequently is sufficient. True, different sizes of aggregate require different amounts of asphalt, but the saving obtained by using a certain size may justify considerable inconvenience in obtaining such size. In general, two sizes of aggregate will meet every condition of retreatment, suitable for use of only 0.1 and ⅓ gal. per square yard. The saving so made would be sufficient to take care of a substantial increase in mileage.

Road Mixes

In road-mix work especially is the use of too much asphalt noticeable. The usual thickness of macadam aggregate road mix is approximately 2 in. compacted depth, and use on this of over 1¼ gal. of rapid-curing cutback asphalt per square yard is sheer waste, yet in many places 1½ gal. or more is used. With road-mix or plant-mix surfaces laid on a stabilized subgrade (usually waterproof), a very thin coating of asphalt around the aggregate is sufficient, provided a tight seal coat is placed on the surface. Even with dense graded mixtures of the coarse aggregate type, a 6% asphalt content is usually sufficient, or about 1.2 gal. for a 2-inch thickness. In fact, since the strength of such a surface depends upon the interlocking of the aggregate fragments, this percentage might be even further reduced if pains are taken to place a proper seal coat. Such a seal coat does not require a large quantity of asphalt, but only a correct application of cover coat aggregate and bituminous material. If the aggregate is applied *first* and thoroughly broomed into the surface voids, 0.15 gal. per square yard may suffice and give better results than 0.25 gal. applied first and the cover coat last.

There are three principal steps in the manufacture of asphaltic concrete, either hot or cold mix: 1—Assembly of materials; 2—mixing in correct proportion; 3—placing and compacting on the roadway.

Most specifications sufficiently specify the quality of aggregates, many even setting forth the exact gradation and physical properties of all materials, but for mixing them they permit the use of a plant with no controls, the product of which may not give the desired proportion of mix. In some plants the screen might as well have been omitted so far as any effect on size of material in the bins is concerned; while the weighing devices gave no more accurate results than counting wheelbarrow loads—conditions found in the construction of concrete roads ten or more years ago but not now. Recent developments in constructing asphaltic concrete surfaces under similar rigid specifications have demonstrated that any desired strength or smoothness of surface may be obtained equal in every respect to that possible in any other material, and frequently at much lower cost.

To lay a pavement on a large scale similar to laboratory specimens necessitates rigid plant control and finishing operations. For this, the minimum requirements are:

(a) Capacity of plant sufficient for job in hand.
(b) Adequate drying of coarse and fine aggregate.
(c) Screening to correct sizes and segregation in bins so that overflow is prevented.
(d) Accurate weighing of the several sizes of aggregates composing each batch.
(e) Accurate weighing of asphalt for each batch and provision for introduction into mixer over the entire width.
(f) Accurate control of asphalt temperatures, through ample storage facilities, jacketed lines, etc.
(g) Automatic control of mixing time with suitable locking devices.
(h) Mechanical finishing wherever possible.

For city work where manholes and other service outlets are numerous, hand raking and finishing is often necessary for any type of construction, but for the building of surfaces on state and other rural highways, machine finishing should be made mandatory. Such finishing not only produces riding surfaces of unsurpassed smoothness but will reduce the cost of doing this work as well. Specifications governing the construction of asphaltic concrete, whether it is coarse graded, fine graded or sheet asphalt type, should set forth these fundamental requirements in detail, and in the average book of specifications should occupy not less than fifteen pages.

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Do you make regular use of the Readers' Service Dept.?—see pp. 34, 52, 53

Roadside Improvement and Beautification

By Wilbur H. Simonson

Landscape Architect, Bureau of Public Roads

This is the first of a series of three article which Mr. Simonson has prepared from data presented by him to the American Society of Landscape Architects

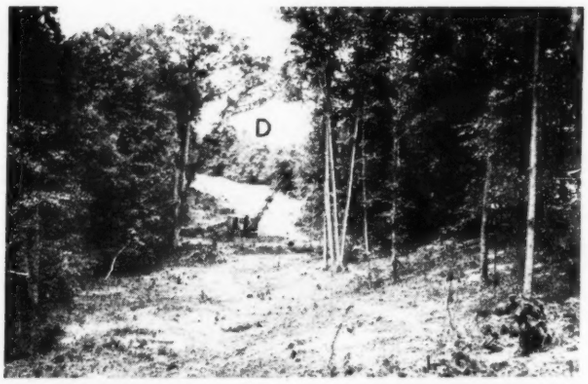
"It is universally recognized that a very large percentage of the total use made of the highways is for recreational and social pursuits. Reasonable expenditures for providing pleasant and beautiful roadsides are wholly consistent with sound public policy, particularly now since this type of work can be used to advantage in providing employment that reaches rather different classes than normal highway operations."

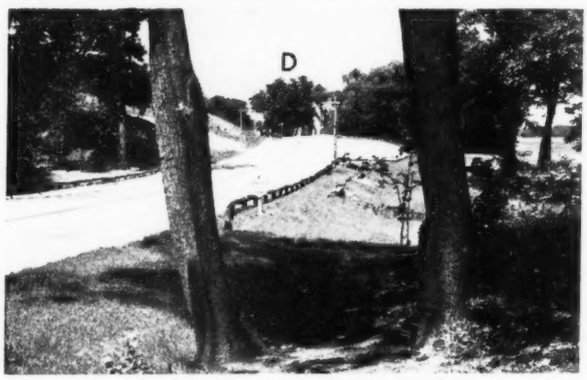
"We can confidently expect that in the near future communities which have been relying upon well-improved roadways to attract outside traffic, will be placing greater reliance upon beautiful highways. Already provision has been made for extensive work of this character in some of the States through the use of work relief labor, with other costs furnished by the use of highway funds. There is no reason why cooperative work of this character cannot be greatly extended." *Thomas H. MacDonald, Chief of the U. S. Bureau of Public Roads.*

THE conservation of the scenic values along highways, and the associated landscape architectural problems involved in the development of the roadsides along them, are subjects of growing public concern. Relatively recent national legislative* and administrative† efforts have focused attention on the planned-development of the roadsides, which indicates the Government's recognition of the potential and widespread interest in the economic development of highways in an attractive manner.

*The National Industrial Recovery Act (approved June 16, 1933).

†The Rules and Regulations (approved June 23, 1933) by the Special Board for Public Works for Carrying out the Provisions of Title II, Section 204, of the Recovery Act for Constructing Public Highways and Related Projects in Accordance with Provisions of the Federal Highway Act, approved November 9, 1921, and amended May 21, 1928.





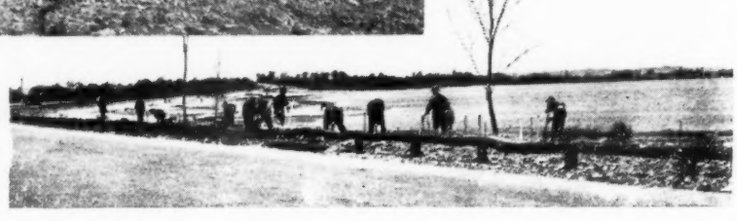
FITTING THE HIGHWAY CLOSELY TO ITS NATURAL SURROUNDINGS

Dense screen of trees carefully thinned out to open up vista (including trees at D) and desirable outlook. Turn-out at right introduced at relatively little cost. Note also graceful end-flares of the railings; culvert head wall faced with native stone with vines growing about it; low locust bumper rail outlining and confining the motors within the parking space; the easy, rounded grading of the slopes, and the planting of the slope on the left in contrast to the seeding of the flatter slope on the right. Turnouts at vantage points give motorists opportunity to enjoy beautiful views. As most such points are at the tops of hills where drainage ditches are of little importance, it is easy and relatively inexpensive to provide these turnouts, requiring only the smoothing of a small area, with some incidental bumper rail construction.

Diversifies and Spreads Employment

Roadside improvement, being largely handwork, affords unusual opportunities for the employment of labor. A well-balanced program of roadside improvement utilizes unskilled labor to a maximum degree. More than 90 per cent of every dollar spent for this kind of constructive work ultimately arrives in the pay envelope of labor. Of this amount, approximately 65 to 70 per cent is a direct benefit to local labor, and 25 to 30 per cent is a benefit to other labor indirectly engaged in supplying plants and incidental materials and equipment. Roadside improvement is a most effective means of spreading work where labor employment is most needed. It spreads employment over all seasons

Farmers' teams with equipment of various kinds help to prepare graded areas for final planting or seeding.



A landscape planting crew preparing newly graded area for final planting by adding top soil and humus. The large trees were moved in to dominate the planting, which will soon cover with green the raw construction scars.

of the year and distributes the benefits of diversified employment among all communities.

Roadside improvement has an economic purpose as well as an esthetic value. While providing so effectively for the direct employment of labor, it also creates tangible assets of a reasonably durable nature. It eliminates a large number of traffic hazards, reduces wasteful erosion and maintenance, conserves and enhances highway values, and produces a natural harmony of environment for a more complete and useful highway.

Roadsides an Integral Part of the Highway

The greater emphasis now being placed in highway programs upon the improvement of the roadsides accords with the frequently expressed view of Thomas H. MacDonald, Chief of the Bureau of Public Roads, that the task of improving America's highways will not be completed until adequate attention has been given to the improvement of the roadsides as well as the roadways. Mr. MacDonald analyzes the problem briefly as follows:

> Four major movements are needed to beautify and enhance the usefulness of the highways. They are:
>
> First, the complete elimination of advertising signs, not only those within the rights of way but also those on private property along the rights of way;
>
> Second, the removal of oil filling stations, "hot dog" and lunch stands, and roadside markets that encroach upon the right of way; and regulation of distance from rights of way at which such establishments may be located on private property;
>
> Third, the planting of trees and shrubs along the roadsides; and
>
> Fourth, the location, design, and construction of the highways in such manner as to preserve the natural beauty of the countryside.

Roadside improvement consists essentially of fitting the details of highway construction into close relationship with the surrounding countryside to produce a harmonious and natural highway setting. The proper design of the whole-constructed highway, from the point of view of appearance, is the physical foundation for a constructive improvement, so that whatever is done to improve the roadside in the course of preserving or planting trees and ground-cover is reasonably certain to remain undisturbed. All the desirable features existing along the highway should be carefully preserved. The elimination of nuisances, wherever undesirable conditions exist along the highway, insures an orderly and clean appearance. The introduction of appropriate planting is the last and final step in a logically developed comprehensive roadside improvement. Roadside improvement may be applied to all classes of existing old roads or to proposed new highways. A definite plan and a general policy should be adopted and continuously followed to produce the greatest service at the lowest cost.

Adequate Right of Way Essential

The possibilities of roadside improvement are enhanced as wider rights of way are provided. Future traffic needs should be studied and a decision made as to the probability of future surface widening. A permanent improvement should be contemplated so that plantings will not be destroyed in a few years should widening become necessary. Additional width of right of way may be desirable in locations where particularly effective landscaping can be done, where a natural grove of trees can be included, or where it is desired to plant screening material to hide an unsightly area.

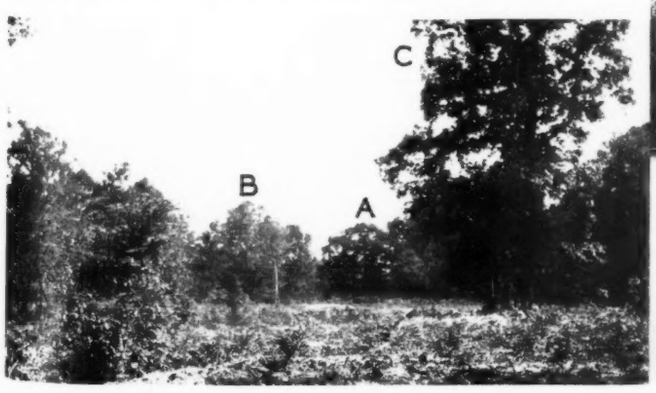
Selection and Length of Projects

Projects for roadside improvement may vary considerably in length and may involve both new construction and roads previously improved. Some projects may extend for several miles, with 3 to 5 miles as a desirable average. One mile should be considered as the minimum length for a project. A reasonable length is necessary for economy in design and supervision, and for effectiveness of results. In making a beginning of this work, it is desirable that projects be located where they will be seen and enjoyed by the greatest number of people and serve as demonstration projects. Main highways near large cities are therefore the most desirable locations.

Projects for roadside development need not necessarily consist of a complete development, including the final planting. The planning should contemplate a complete development but present initial work may be limited to grading, to advance preparation of the soil, to the salvage of collected stock, and to finish grading and seeding or sodding, with the purchase and planting of nursery trees and ground cover deferred to a later time.

(Continued in April issue)

A well-planned comprehensive roadside improvement, which indicates the value of conserving natural growth along the highway borders by means of careful location with a regard for the trees and by means of flattened slopes graded in a natural manner. The saving of these occasional trees near the roadway furnishes the highway an interesting skyline character as soon as the work is completed. Too often, the policy and specified requirement in construction contracts and in maintenance work has been to clear the right of way borders of all trees and other natural growth without any consideration whatsoever for those landscape assets which in no way interfere with the highway work or with the safety of traffic. True conservation means the judicious selection of plant growth for removal and the careful trimming of trees in an artistic and scientific manner under competent landscape supervision, and NOT *the careless "butchering" of trees and the haphazard cutting of undergrowth along the highways. Considerable thought should be given to this phase of roadside improvement work where vista overlooks or other clearings and openings are contemplated. A widening in the pavement along the low rail at the left of the roadway provides suitable turnout parking for those intending to stop to picnic or to enjoy the views afforded at this section of the highway.*



● This type is one of the oldest established pavements which has been used mainly on city streets and primary highways. It is easily repaired for service cuts, is low in maintenance cost, quiet, non-skid, and easy to clean and keep in a sanitary condition. It is used for resurfacing streets and for new construction.

It consists of a wearing course and a binder course, each usually being laid to a depth of one and a half to two inches, depending on traffic, on a suitable foundation of sufficient strength to suit the traffic.

The wearing course consists of a hot mixture of paving asphalt cement, mineral dust and sand:

Typical Mixture

	Per cent by Weight
Asphalt Cement	10.0 to 13.5
Mineral Dust	10.5 to 15.0
Sand	71.5 to 79.5

The binder course consists of a hot mixture of asphalt cement, sand and mineral aggregate.

Typical Mixture

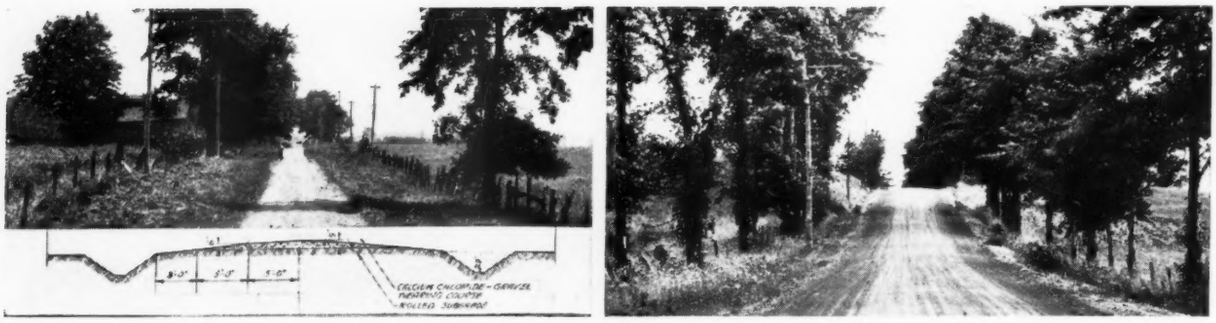
	Per cent by Weight
Asphalt Cement	5 to 8
Sand	25 to 35
Mineral Aggregate	60 to 70

The foundation can consist of a newly constructed base course such as hydraulic cement concrete, asphalt cement concrete, macadam, or other types which have sufficient strength for traffic requirements.

STANDARD OIL COMPANY
(INDIANA) 132-A
910 South Michigan Avenue Chicago, Illinois

ASPHALTS FOR EVERY PURPOSE

Do you make regular use of the Readers' Service Dept.?—see pp. 34, 52, 53



A stabilized road before and after, and a section of the finished road

Low-Cost Stabilized Road Construction

By R. B. Traver
County Superintendent of Highways, Onondaga County, N. Y.

THE policy of the board of supervisors of Onondaga County, New York, until 1932 had been to concentrate all highway construction efforts on concrete construction. However, in that year the board, owing to the unemployment conditions existing, decided to change to a low-cost construction giving maximum expenditures of money on labor and not over 10% on materials; also that 1,000 men be put to work, which was three times the normal force previously employed by the county for highway purposes. (See PUBLIC WORKS for October, 1933). Therefore plans were developed for stabilized gravel stage construction, properly graded and drained.

We may define a stabilized gravel road as one that will give proper support for wheel loads, will not become slippery in wet weather nor ravel or become dusty in dry weather. Such a surface is obtained by using coarse aggregate, fine aggregate, silt, clay and calcium chloride.

Before any actual construction is started on a road it is surveyed for alignment, topography, and cross sections, from which data the office works up new alignment, new grades, and balances the dirt. All curves 8 degrees or sharper are banked ½ inch per foot on the curve proper. Our standard section, which is used for all our construction, is 26 feet between shoulders, with a ditch 28 inches deep below center line grade. Ample drainage has been an important factor in the success of our roads.

In actual construction, the first procedure is clearing and grubbing, followed by laying permanent, ample culverts and ditching, the material from the latter being used in building the subgrade. The rough grading is completed, being bladed and rolled, if necessary, to form a stable smooth surface. Guard rail is placed at the necessary points. All the work is done by hand labor, except for any blading and rolling necessary. For the wearing course the best type of material would be gravel of the following composition:

50 to 60 per cent of gravel above a 10 mesh screen
10 to 20 per cent of coarse sand above a 40 mesh screen
10 to 20 per cent of fine sand through a 40 mesh and retained on a 270 mesh screen
10 to 20 per cent of silt and clay through a 270 mesh screen.

The soil fines passing the No. 40 screen should have a plastic index from 8 to 12. (The plastic index is the measure of the cohesive properties of a soil. (The function of the gravel is to supply rigidity and high internal friction. It also adds to the mechanical stability of the road surface. Coarse sand serves the same purpose as gravel and also locks the gravel in place, and the fine sand fills the voids in the coarse sand. Silt has high capillary properties and serves to retain the calcium chloride, but contributes nothing to the road's stability and has no cohesive properties, whereas clay supplies cohesion and toughness and fills the voids completely, making the road surface impermeable, and also serves as reservoir for the calcium chloride.

Gradation plays a very important part in the materials for this class of road, but we have not found it necessary to insist on the *close* gradations or in keeping the plastic index within the *narrow* limits in the materials at their source, and have produced excellent wearing courses without elaborate mixing. Although gravel beds are numerous throughout the county, none of the material can be considered as ideal, it being either too coarse or too fine, and often without sufficient binding material and frequently contains an overabundance of large stones. There are several crushed stone plants in the county, and run-of-crusher screenings have been used successfully in the construction of several roads.

We have found subsoil that we felt was very good, but never one which met text book perfection, and this is also true with our gravel beds. We use bank run gravel, selected mainly because of nearness to the construction, but subjected to visual inspection supplemented by simple field tests; in a few cases where there was more than one bed in close proximity, an analysis

Grading and ditching with local teams and labor

has determined the choice of beds. The gravel is loaded on trucks by a shovel and hauled to the job, where it is rough spread by the tail board of the trucks, and then spread to a depth of 9 in. at the center, 6 in. 5 feet from the center, and to a feather edge 10 feet from the center, giving a 20 foot gravel surface.

The large stones are removed from the surface by raking, and the surface is shaped by blading, followed by rolling and honing, filling depressions and cutting off humps. The riding qualities are built into the road at this stage. The rolling is done from the edges toward the center, and after a thorough compaction the road is opened to traffic for a period of from 10 days to two weeks. During this time, if there are any unfavorable peculiarities or characteristics of the gravel, they will show themselves and must be corrected.

The most frequent unfavorable conditions are an excess of coarse material (which may be gravel with low binding properties) or of fine material or clay, which causes a slippery road. The former is remedied by blading or scraping some of the shoulder dirt over the surface of the gravel, or by placing on the surface a layer of shale sand which weathers, giving a clay binder. The clay condition is corrected by spreading the road surface with 1 to 1½ inches of limestone chips, or with clean sand. By these two remedies, we have been able to correct practically all of our difficulties.

In one or two instances, where we have not been able to procure any gravel, we have used crusher run from a nearby stone quarry, which contains soil, dust, screenings, and No. 1, 2, and 3-A stone. In each case we predetermined the qualities which were lacking by a thorough examination and were able to supply the necessary material from the road subgrade. Sufficient of the latter material was windrowed along both sides of the road, and when the crusher run had been spread on the subgrade the soil was brought on top by the use of graders, and thoroughly mixed with it by drags or harrows. These simple operations produced a product which met all the requirements of a stabilized material. For our standard section we use 1,711 cubic yards of gravel per mile of road. Where crusher run was used, only about 800 tons per mile was placed, at a cost of 15 cts. per ton in our trucks.

The road surface is now smooth, compact and, from all visual appearances, satisfactorily stable. However, should traffic be permitted to use it for any extended length of time, it would soon become rutty, unstable and dusty. To give satisfactory service, the surface must be kept moist and this we accomplish by a treatment of calcium chloride, spreading it with an ordinary lime spreader drawn by truck, at the rate of 1½ lbs. per square yard, or 8.8 tons per mile, the center strip receiving a heavier application due to the greater depth of gravel. The average daily mileage per truck is about 5 miles of complete surfacing. The average cost of the

Applying calcium chloride to surface

initial treatment of our roads is $240 per mile. Our complete stabilized treated wearing course costs from $1,750 to $2,250 per mile.

The calcium chloride supplies the moisture necessary to bind the soil fines into a well-compacted, stable surface. On grades as high as 10 per cent and over the gravel is held just as firm as on the level surfaces, with no indications of erosion or raveling. We find that it is not necessary to wait for favorable conditions of moisture or dryness to apply the calcium.

As yet it has not been necessary to add maintenance gravel. Our maintenance consists of honing the surface as required, and re-treating the surface with calcium chloride once or twice each year. We have found that one pound per square yard applied in the spring and from ¾ to 1 lb. applied during the summer is sufficient. Honing is usually done following rains, so as not to waste chloride. We find that honing two or three times a year is all that is necessary for the majority of our roads. However, on some roads, where the travel is in excess of 800 vehicles per day, it is necessary to hone the surface about every four weeks. But honing is a small item in the maintenance cost. Our general spring scraping is done with an Austin No. 77 grader, which will cover 5 miles of surface per day at a cost of less than $5.00 per mile. For any honing done after this we use a Walter Snow Fighter, using the rut scraper as the blade. We do not maintain a floating surface or a loose mulch, and therefore, it is not necessary to give the surface the daily maintenance usually given to gravel roads. Present indications are that additional gravel will not be necessary for several years, as the loss from the surface is very small.

By the end of 1933 a total of 335 miles of these stabilized gravel roads had been completed. Many of them will be maintained as satisfactory farm-to-market roads; others will become important thoroughfares and warrant a concrete surface, in which event the stabilized, well compacted wearing course will form an ideal subgrade so that a thinner concrete slab may be used, and it is reasonable to assume that the saving in concrete will offset the initial cost of laying the gravel.

The public at the start were generally antagonistic to this kind of road, but land owners along these calcium treated gravel roads now approve of them and request that we do not change the type in the future. During the past three months all of our projects under construction have been taken over by the CWA, and I understand that this type of work is very satisfactory to the organization for the use of its funds.

Road under construction, using CWA labor

Recent Booklets on Low-Cost Road Construction

Any of the following will be sent free on request to the Readers' Service Dept. of PUBLIC WORKS *magazine.*

Distributors

206. Kinney distributors of from 600 to 1,700 gallon tank capacity with heating system and the Kinney jacketed pump having a capacity of over 400 gallons per minute are described in a new catalog just published by the Kinney Mfg. Co., 3533 Washington St., Boston, Mass.

Dust Control

209. "3000 men put back to work in a single county." A new folder just issued by the Solvay Sales Corp., 61 Broadway, New York City, outlining a road program which is a relief program. Sent promptly on request.

210. "How to Maintain Roads," by the Dow Chemical Company, Midland, Michigan, is a manual dealing thoroughly with dust control, road building and maintenance.

211. "Principles of Road Soil Stabilization," a new booklet just issued by The Columbia Alkali Corporation, Barberton, Ohio. Gives a clear, concise picture of what road soil stabilization is and how it can be accomplished.

212. "Wyandotte Calcium Chloride Prevents Dust the Natural Way,"—a publication, fully illustrated, treating on Dust Control, economical road maintenance and methods of application, issued by the Michigan Alkali Company, 10 E. 40th St., New York City.

Bituminous Materials

225. A comprehensive manual on the "Use of Emulsions for Street and Highway Construction and Maintenance," discussing types, uses, relative costs, construction details, etc., will be sent promptly on request by Headley Asphalt Division, Sinclair Refining Co., P. O. Box 66, Marcus Hook, Penna.

226. "Asphalt Surfacing Materials for Low-Cost Roads" is a handy, 28-page booklet illustrating the many types of road surfaces which can be constructed with Texaco asphalt materials. Well illustrated and contains tables of amounts of stone, sand and asphalt required. Sent promptly by the Texas Company, 135 East 42nd St., New York, N. Y.

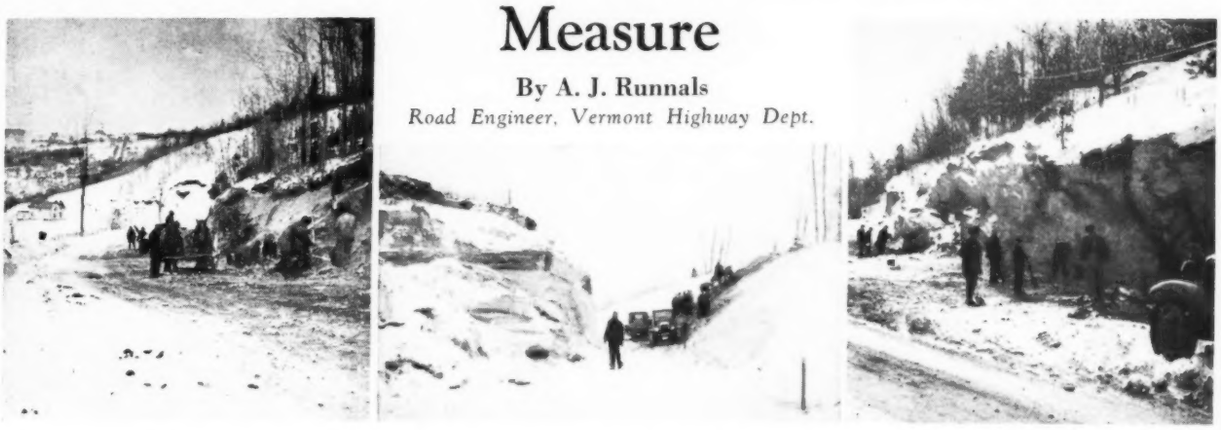
227. "Asphalt for Every Purpose," a 44-page illustrated booklet describing Stanolind Asphalt products. Standard Oil Co. of Indiana, 910 So. Michigan Ave., Chicago, Ill.

228. A new booklet has just been issued by The Barrett Co., 40 Rector St., New York, describing and illustrating the uses of each grade of Tarvia and Tarvialithic. 32 excellent illustrations.

229A. Surface Treatment Types, Asphalt Road Construction Manual No. 2. Full details on surface treatments. 14 chapters, 128 pages. The second of those tremendously valuable and handy little manuals put out by the Asphalt Institute, 801 Second Avenue, N. Y. Sent on request.

Day Labor Work on Rural Roads as a Relief Measure

By A. J. Runnals
Road Engineer, Vermont Highway Dept.



Even winter conditions failed to prevent day labor work on Vermont roads. These pictures were taken during the winter of 1933-1934

Day Labor Work can be defined as highway construction by labor, teams and trucks employed by a state or municipality under the direction of superintendents and foremen hired by the same organization, this type of construction being in direct contrast to contract work where the hiring, firing, purchase of materials and rental of equipment are the duty and function of the contractor.

Rural Roads refers to primary road feeders which carry farm-to-market transportations, on which the distance to town should be the same spring or fall, rain or shine, being the only outlet for much farm produce dependent on low-cost transportation.

Relief Measure means direct relief to unemployed thousands through the medium of highway work instead of furnishing grocery orders, free meals and rent checks. I firmly believe that "Charity, unlike Chesterfields, does not satisfy."

VERMONT has employed force account or day labor work on main and secondary road construction since the beginning of Federal aid, spending in this way some four million dollars, or approximately 24% of the funds allotted to the state by the government.

State aid work in Vermont is carried on in each town in the state and consists of constructing or improving feeder roads, done entirely by day labor under local supervision. Thus each town receives real relief in furnishing financial aid to its local labor, amounting to $2,000 to $4,000 a year. For years the state tried to find a way to insure the employment of Vermont labor and trucks on contract projects—on some contract work hardly a dollar of the cost went to Vermont labor, trucks or materials, but no way has been found but to employ the day labor method.

We feel that we are justified in adhering to the day labor method by the following paramount considerations: Better employment of local common labor; employment of supervision resident in the locality of the project or at least in the state; use of equipment owned by the state or municipality and operated by men resident therein; better use of local materials that enter into the construction; and, finally, a saving in dollars through construction at a figure lower than is possible by contract.

A recent engineering magazine quoted Chairman Scott, of the Oregon State Highway Commission, as saying that one-half the sum expended by force account could do the same work on a competitive contract basis, and that "We do not believe that any method should be employed where a dollar is required to do what fifty cents would do under proper procedure." In the latter statement I heartily agree with Chairman Scott, but I believe that force account construction can be carried on at a cost equal to contract figures if projects adaptable to this type of construction are undertaken and if competent supervision is employed. After all, with either day labor or contract, competent supervision spells success.

R. B. Traver, county superintendent of Onondaga County, New York, says: "The county road program was set up in 1911 and for a few years all work was by contract but the results were unsatisfactory. Since 1915 all work has been by forces of our department. In all we have built over 600 miles of county roads, macadam and concrete and stabilized gravel. We are well satisfied with the results obtained—and can see no reason why costs cannot be kept comparable with those done by contract—and feel we have an organization that is comparable to that any contractor might have. We are able to keep intact during the winter months a skeleton organization sufficient to carry on normal construction. These men are used in the winter time on repairing equipment, sanding hills and on snow removal. Our men are instilled with the same spirit in regard to cost and efficiency that is required of contractors' men. We further find that, if the department is properly supervised, it is possible to practically eliminate the effect that politics could have in the layout and work."

Road construction, properly localized and efficiently performed, generally employs more labor than any other type of public work. Types of work well adapted to day labor are: clearing of right of way, cleaning of ditches and culverts, clearing and widening of shoulders, clearing of obstructions for proper vision, widening curves, sloping banks and drainage construction. In addition, we have more extended work—construction of secondary projects, ranging in size from a five or six thousand dollar job, requiring a small local construction organization, to the larger projects, using competent organizations and a larger amount of machinery.

I am indebted to L. D. Barrows of Maine for a brief synopsis of day labor work carried on last fall and this winter in his state. For several years Maine has carried on an extensive secondary road day labor program and has, during that time, built up an experienced organization and accumulated equipment costing thousands of dollars. With this organization and equipment the state was able to give immediate employment on N. R. S. projects to some 6,400 men. The result was to get the maximum number of men off the relief lists in the quickest possible time. The projects were small, usually limited to about $8,000—too small, in the Maine highway official's judgment, for efficient contract construction. Furthermore, cooperation of local authorities with the state supervisors provided for small job organizations quickly and there was little waste of funds through poor management, no excessive use of machinery where hand labor was as efficient, no delays in preparation of plans and advertising for contract, no excessive construction costs and a state-wide employment of foremen and machine operators.

Without question, the best relief obtained from day labor work is that where there is no substantial expenditure in the purchase of materials and no great use of machinery. This method of construction on bituminous construction or gravel roads offers an opportunity for the largest possible percentage of the expenditure to go for labor.

Vermont Figures

In Vermont, approximately 35% of the total cost of concrete roads constructed by contract went for labor and materials within the state, and 45% of the cost of bituminous construction. (These figures apply to work done before the introduction of National Recovery requirements; they would now, I believe, be increased by the amount of skilled labor required.) In gravel or mixed-in-place construction on a feeder road, 86% of the cost is paid to labor, trucks and teams.

These figures are nothing new or startling. The fundamental fact is that the rural roads lend themselves to day labor construction, and the heavy, expensive machinery used by contractors is not required, the average job having only a reasonable amount of grading, as usually no extended effort is made to obtain the lines and grades required on trunk lines. Paving equipment is not required, as a low-cost surface is in keeping with traffic requirements and thus requires only a drag or road machine and a tractor. Roadside production will usually furnish the aggregate for the surface, and foundation material is from local gravel banks or from nearby stone walls. No extensive overhead is necessary and, all in all, we have a type of construction that naturally adapts itself to day labor methods.

Of the total money spent in Vermont to date on Civil Works, 60 to 70% has gone into road construction and in most cases these jobs were started immediately after the funds were made available. Furthermore, this type of work has been more adaptable than any other to winter construction—even this severe winter.

Day labor work carried on with the idea of economical costs and proper construction must be undertaken with complete knowledge at all times of the cost of the work, and this should be obtained through a simple cost system, accurate to the degree required and available weekly to the superintendent and office. I believe that a subdivision of the items of work into grading, base, drainage and surface give the required divisions of the work. All expenditures, properly charged to these items, with estimates of quantity of work as per-

formed, give sufficient accurate data to enable a competent superintendent to keep costs to the lowest possible figure.

There is a very decided danger of over-emphasis of cost accounting in day labor construction. To properly and efficiently carry on an extensive force account program for all construction, a tremendous overhead would be required, involving clerical help, timekeepers, superintendents, foremen and machine operators, and a large number of these would have to be carried through the winter to avoid rebuilding the organization every spring. Politics, graft and other dangerous items would have a tendency to enter the work. However, I feel that there is a decided need of sufficient force account organizations to carry on a part of a state's construction program.

Rural road day labor construction will quickly put money into circulation as it offers employment to a large number of men and such employment is spread over a large area by the very nature of the work. The work as provided is suitable for idle men who represent a wide variety of occupations and will, at the same time, build most miles of road per dollar, where they are most needed. Feeder roads do not require the time-consuming preliminaries necessary on trunk line improvements before construction can start and certainly in nearly every state there are miles of this class of road, requiring improved grades, drainage construction, elimination of mud holes through adequate foundation construction and the building of an all-weather year round surface.

A safe course should be provided between machine and hand labor. Increasing employment on highway work through hand labor must not be at a destruction to the equipment industry nor at too great a loss to economical highway building.

The above is slightly condensed from a paper before the Association of State Highway Officials of the North Atlantic States.

Report of Project Committee on Use of High Elastic Limit Steel as Concrete Reinforcement

H. J. Gilkey, Chairman, Professor of Theoretical and Applied Mechanics, Iowa State College

Under the joint auspices of the Highway Research Board and the Engineering Experiment Station of Iowa State College, George C. Ernst, special research assistant, has investigated the use of high elastic limit steels as reinforcement in concrete. Many questions have arisen relative to the use of this type of reinforcement. This preliminary investigation covers the following points:

A. A study of the design aspects of higher working stresses.
   1. Economical stresses,
   2. Possible effect on deflection.

B. Practical use of higher working stresses in design.
   1. Choice of specifications,
   2. Choice of design diagrams,
   3. Redesign of a deck girder highway bridge,
   4. Design of columns.

C. Possible economies of high elastic reinforcement.
   1. Quantity of material,
   2. Formwork cost,
   3. Increased cost of higher strength materials.

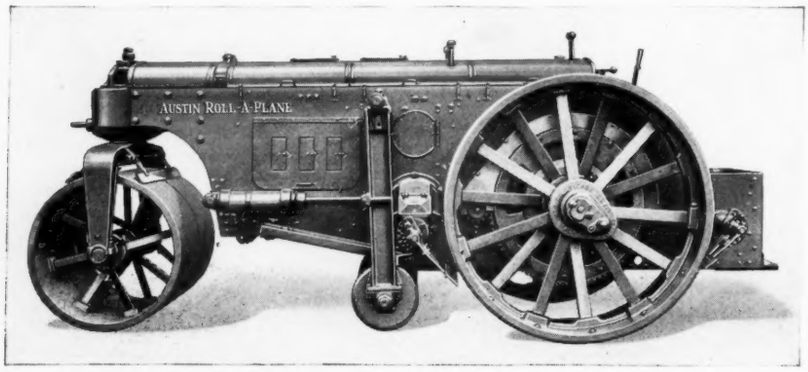
It is concluded that high elastic limit steel reinforcement is satisfactory with a working stress of 25,000 or 30,000 p.s.i. and has advantages in load-carrying capacity and in economy of design and construction.—*Highway Research Board.*

New Developments in Road Building Equipment

Three Machines to Build Roads Better, Quicker and Cheaper

The Austin Roll-a-Plane Smooths High Spots

A new type roller, which is especially designed for producing the maximum smoothness in blacktop or other type of surfaces which require rolling, has been announced by Austin-Western Road Machinery Co., Chicago, Ill. The illustration shows the machine with the center roller in operating position. When a high spot is encountered, the front roller may be lifted partly or entirely from the surface of the road, and as much as 85% of the total weight of the roller concentrated on the center roller. Its use tends to displace these high spots and lift up neighboring low spots, thus attaining a smooth-riding surface.



Smooths the High Spots—Austin Roll-a-Plane

By making easier the establishment of a regular and smooth grade line, this roller reduces the costs of subgrade preparation. In this field, and in maintenance and reconstruction work this roller should have a wide field of usefulness. A maximum of 20,375 pounds can be concentrated on the center roller. The maximum lineal inch compression of the center roller is 452 pounds.

Public Works Handy Man

"For all manner of odd jobs in Schoharie County, New York, this multiple-purpose P & H shovel mounted on a Linn truck chassis is doing a wonderful job," states L. J. Wright, Superintendent of Highways in that district. Because this unit can be equipped with shovel, dragline, crane or hoe to handle every type of job, it is on the go constantly. Beyond its ability to get quickly from place to place, it has the advantage of decreased ground pressure on improved roads—at the same time, it provides more certain, positive traction. Ever since this equipment (P & H model 202,-B) has been in service, it has attracted the interest of city, county, and state officials. In addition to the run of work for the County Highway Department, it has also seen service in the New York State Highway Department for general widening of curves and other odd jobs.

With a shovel capacity of ½-cubic yard, its uses include cleaning of creek beds, grading, general excavating, handling sand and stone from stock pile and bank, removing mountain slides, trimming slopes, sloping shoulders, digging ditches, swimming pools, culverts, and sewers (dragline and hoe) and material handling with clam.

The truck is one of the latest Linn models with four speeds forward and one in reverse, enabling it to climb steeper grades and to get quickly from one location to another.

Handy Man—a P & H Shovel on a Linn Truck

The Federated Sales Service, 537 Commonwealth Ave., Boston, Mass., have been appointed by a manufacturer of a cement admixture to build up a national sales organization of commission Sales Representatives. Applications from manufacturers Sales Representatives are invited.

Saving on Material Spreading

Seal coat was covered with chips from ½″ down, immediately following the distributor, in a single, back up spread. No wheel touched the bitumen coat. Traffic was stopped for possibly five minutes while the distributor sealed one side (10′) for a short distance and returned down the other side. Then the truck spreading chips backed down the middle followed by any traffic in that direction. This was repeated, short sections at a time, for ten miles. No long delays or danger to traffic. Even penetration resulted in a smoother surface. Material saved ran 30%. This handy and cheap equipment is produced by Kob Mfg. Co., La Crosse, Wisc. It is shown in action in the illustration below.

The Koch Spreader at Work on a 20-ft. Road

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Water Chlorination Economies in Chicago

The Division of Water Purification of Chicago uses about 1,500,000 pounds of liquid chlorine a year. In 1932 the city paid 5.29 cts. a pound in 100-pound containers, but as the market price in ton containers was 2.15 cts., a large saving seemed possible. According to the engineer of water purification, Arthur E. Gorman, "The most serious objection to the use of the ton containers at the pumping station has been the fear that there would be a greater hazard from leakage from a container holding 2,000 pounds of chlorine than from a 100-pound container. This is especially pertinent in view of the fact that many of the pumping stations are located in thickly populated neighborhoods with some in close proximity to hospitals, schools and hotels. Studies in cooperation with the Designing Division indicated that the objection could be overcome by making provision for the complete absorption in caustic soda of the chlorine from a ton container. In case of leakage, the pit in which the container is placed could be flooded with strong caustic solution and the chlorine removed without endangering life. The cost of making such provision, however, at existing pumping stations was found to be so great that the annual depreciation and interest charge on the new installation would practically balance the savings which would accrue from the purchase of chlorine in the larger containers.

"But for the new central pumping station and the south side cribs the use of ton containers was found to have real advantages. It would mean less space, fewer valves and fittings, and greater ease of operation. With these two chlorinating plants treating an average of over 500 million gallons daily of water, or about half of the city's supply, the potential business for ton containers would become attractive for the manufacturer. This was reflected in the low bid received for chlorine in 100-pound cylinders on Dec. 21, 1932, the price dropping from 5.29 cts. to 3.48 cts. per pound."

Plans were made for using the ammonia-chlorine process at the cribs, obtaining chlorine in ton containers and the ammonia is ammonium sulphate crystals, with provision for at least 40 days' storage on the crib (which storms and ice sometimes cut off from communication with the shore for several days at a time).

Chlorine is applied at all twelve pumping stations under the strict supervision of the Water Safety Control Section. The lowest rate during 1932 was 3.0 pounds per million, the maximum was 10.0 pounds, and the average for the year 4.41 pounds.

B. Coli were found at each of the five cribs, for a minimum of 35 days during the year at two cribs to 70 days at one of them. At one crib, 30,000 B. Coli per 100 c c were found once, 2,400 were found from one to three times, 240 from 8 to 22 times, and 38 from 35 to 70 times. The average B. Coli per 100 c c of water at the intake cribs varied from 1.6 to 1,010, but the average of 9,822 samples of chlorinated water collected daily from each of the pumping stations was .105. Samples collected from 27 points in the distribution system showed an average of .319.

Aluminum Paint for City Use

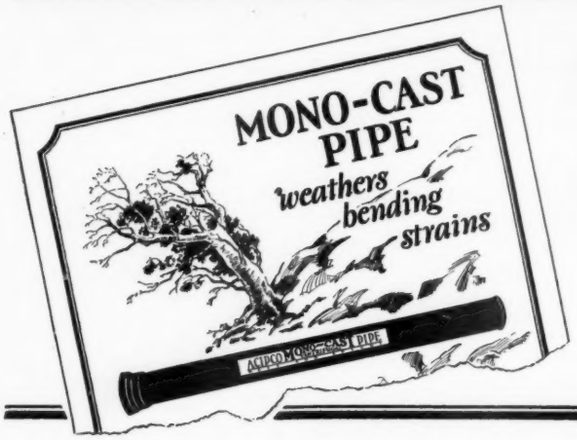
There is apparently a tendency toward the greater use of aluminum paint for highway guard rails, bridges, water towers and tanks, lighting fixtures, etc., the Aluminum Co. of America stating that nineteen states have adopted this paint for bridge painting, and seventeen others use it extensively. Factors to be considered in the choice of paints for the uses mentioned above are good visibility, pleasing appearance and economy.

The desirability of using light colored paint on bridges and guard rails is generally recognized. An illustration herewith shows the illumination by automobile headlight of an aluminum painted bridge. This is an important safety factor. It is stated that such paint has the ability, even in fog or driving rain, to bring out sharply the bridge members.

The durability of good aluminum paint is pretty well known. One example quoted is the George Washington Bridge over the Allegheny river at Pittsburgh. This bridge has not been painted since 1924, but in the nine years that have elapsed, even under the severe conditions that exist in Pittsburgh, the paint has remained in excellent condition. Such paint is resistant not only to the action of acid fumes, but also to the corrosive action of salt air.

When aluminum paint is to be used on steel, it is better to use it as a finishing coat over a high-grade inhibitive primer, such as basic lead chromate or red lead. In the case of wood, it is suitable for use both as priming and finishing coats.

Bridge shows up on a foggy night. *St. Petersburg, Fla.* *The Washington Crossing bridge, Pittsburgh.*
Municipal structures painted with aluminum paint.



OLD-TIMERS WILL RECALL THIS AD

One of a series which appeared in leading trade journals during 1926 and 1927.

WHEN Mono-Cast Centrifugal C. I. Pipe was first offered to the trade 10 years ago, *impact resistance and ability to bend while resisting bending* were urged as outstanding characteristics of this new product. A series of advertisements, one of which is reproduced herewith, was published to emphasize these features.

During the past decade, the advantages of these characteristics have become increasingly apparent through the superior performance of Mono-Cast Centrifugal C. I. Pipe in thousands of widely varying installations throughout the United States and in foreign countries.

And so today—as 10 years ago—we emphasize the fact that the Mono-Cast process of centrifugal casting *in sand-lined molds* produces a pipe which

Weathers Shocks and Bending Strains Both in Handling and Service

MONO-CAST *pipe is at least 33-1/3% more RESILIENT than is required in the U. S. Government specifications. RESILIENCE is the term used to express the amount of work or energy which a pipe will absorb without breaking. The RESILIENCE factor is the square of the modulus of rupture divided by the modulus of elasticity.*

WRITE FOR DESCRIPTIVE LITERATURE

AMERICAN CAST IRON PIPE COMPANY

BIRMINGHAM, ALABAMA

CHICAGO
KANSAS CITY
LOS ANGELES
CLEVELAND
MINNEAPOLIS
NEW YORK CITY
SAN FRANCISCO
SEATTLE
DALLAS

Do you make regular use of the Readers' Service Dept.?—see pp. 34, 52, 53

The Water Wheel

Following are the essential features of the important articles published last month having to do with water works design, construction and operation and water purification, arranged in easy reference form and condensed and interpreted.

ACTIVATED Alum has been used by the Batavia, N. Y., water works since August 28th, 1933, with an intermission of about ten days[47]. This "Black-alum," containing 2% activated carbon, "gives a quicker forming floc which is larger and more easily controlled (than plain alum). The floc or sludge does not seem to decompose in the settling basins or in the filter sand as it did with alum, even when using prechlorination," and "the use of activated alum at our plant has resulted in a 20% reduction in the alum consumption. We have also noticed that we are using less wash water than we did and the filter beds are in better condition." This alum is fed by dry feed machine to the raw water suction well, as was the plain alum before. The settling basin was cleaned after 6 mos. service (an unusually long run) and the sludge had practically no odor. Five days after the temporary discontinuance of the activated alum began, consumers complained of taste and odor in the water, which carries an unusually heavy load of algae.

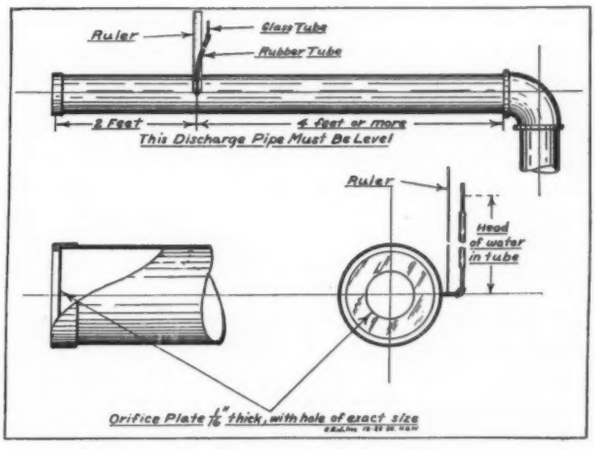
Mixing Chambers built in a dozen purification plants in Alabama with capacities from 100,000 g.p.d. to 3,000,000 g.p.d., called "dual flow compartment type mixers," recommended by the State Dept. of Public Health[46], are easy and economical to construct, easy to clean, very effective in small as well as large plants, floc settles quickly, loss of head is low, and maintenance and operation costs are negligible. A mixer consists of a series (usually 5) of compartments, the water passing from each to the next through a 90° ell in the bottom of the partition wall, entering the ell horizontally and discharging vertically upward. Each compartment has an area of 18 sq. ft. per m.g.d. of filter capacity, the length not more than 1.33 times the width, and depth of 9 to 12 ft. The connecting ells are of cast iron or vitrified clay, of such diameter that the area equals approximately 1 sq. ft. per m.g.d. The discharge ends of the ells should be not more than 8 ft. not less than 6 ft. below the water level in its compartment. (A short nipple in the discharge end may be used to secure this.) The loss of head is about one foot through a series of 5 compartments. This mixer secures the counter currents and impact needed to bring the particles of floc into contact with each other to induce coalescence, with slight loss of head and with no outside cost or mechanical maintenance.

Chlorine in distilled water does not increase the rate of corrosion of *zinc*, but rather reduces the rate at least in amounts up to 5 ppm.[6] With normal drinking water the corrosion rate is less than with distilled.

Pumping Plant Studies for Detroit's Springwells station[2] continued for five years before final adoption. This is a direct pressure system with variation of pumpage load of 1:4. The low-lift pumps had to be placed at least 70 ft. below grade and pump through 12 miles of large tunnel. The water surge of the 210,000 tons of water in the tunnel was a problem. For the low-lift plant alone 21 different schemes were studied, including both vertical and horizontal motor-driven pumps and horizontal steam turbines and water turbines. On the basis of lesser cost for the plant as a whole and greater reliability in the low-lift plant, electric motor equipment throughout was chosen, with an adjoining steam generating plant; using AC motors with combination of constant and variable speed motors. The pump well is 110 ft. deep, 58 ft. inside diameter. Cost of pumping plant and structures, $3,500,000.

A Simple Method of Measuring the Discharge through a pipe (as from a well) by means of an orifice is described by "Johnson's National Drillers Journal."[15] A discharge pipe is used consisting of 6 or 8 ft. of standard steel pipe with diameter such as will give a velocity of about 4 to 8 feet per second (estimating the discharge). Two feet from one end, the pipe is tapped for a ⅛ in. pipe and a ⅛ in. nipple 3 or 4 in. long screwed in so its end is just flush with the inside of the pipe, and the wall of the pipe at the nipple smoothed by filing, and any burr removed from inside end of the nipple by means of a round file.

A steel plate 1/16 in. thick is cut to fit over the end of the discharge pipe and in the exact middle of this a hole is machined, perfectly round with a smooth, square edge, the diameter being one inch less than the nominal diameter of the pipe. The end of the pipe is filed off exactly normal to the axis and the plate fastened against it by means of a special nut or a thread protector. The discharge pipe is screwed into the discharge end of the pump and set perfectly level and turned so that the diameter passing through the nipple is horizontal. Onto this nipple is screwed an elbow and short nipple standing vertical, and over the latter is fitted a 5-foot rubber tube, in the other end of which a short piece of glass tubing is fitted. Have a 2-foot ruler at hand.



Details for constructing orifice flow meter

When the pump has settled down to steady work, the glass tube is raised until the rubber tube is vertical, then lowered till the water runs out of it and raised slowly until the water stands a little below the top of the glass tube. Measure the distance from the center of the horizontal nipple to the top of the water in the tube, averaging the high and low points as the water surges. Hydraulic tables will give the discharge. For example, with a 5-inch orifice and a 6-inch discharge pipe, an 18″ head indicates a discharge of 520 gpm.; a 20″ head, 550 gpm., etc. The result will probably be correct within 2%.

Quick-closing Valves are needed, at least in cities with several miles of mains 20″ or larger,[3] so as to minimize time required to stop flow through a break, should one occur. To close one 36″ valve requires half an hour with four or six men, a leakage of 2 m.g.h. meantime taking place. Mechanically closing devices on trucks do not substantially lessen the time in New York. Electrically closed valves require regular inspection and are expensive. Hydraulically operated valves may have no pressure to operate them when there is a big break. "A type of valve that can be readily operated by hand and quickly closed is very desirable" but a 36″ to 48″ valve should not be closed in less than 5 minutes. "Butterfly valves have been recently designed that it is claimed make a tight shut down, and at the same time are of sufficiently simple and rugged construction to be available for water distribution systems."

Group Management of Water Companies[22] has both advantages and disadvantages, in the opinion of the president of the Community Water Service Co., which operates 46 water works plants in 11 states. He lists as advantages: (a) Availability to all subsidiary companies of more expert direction and counsel than individual companies could afford. (b) The top men of the organization can use their entire time gainfully, reducing their cost to a minimum. (c) Each subsidiary company benefits by experiences of other companies, making possible standards of operation impossible for any one official or officials on a single property. (d) Mass purchasing of materials and equipment, insurance, legal service, auditing, etc., prevents duplication and reduces cost to a minimum. (e) Operation, under single heads, of central and district billing and accounting offices, chemical laboratories, meter repair shops, etc., produces a uniformity of results at lowest possible cost. (f) Standardized methods of design, construction and operation permit great reduction in engineering costs and speed up the work. Among the drawbacks are: (a) Danger of overdevelopment of the functions of the central office, leading to compilation by a large staff of needless data never used. (b) Centralized control carried too far may cause loss of self-respect and ambition in local plant managers, and consumers may be irritated by necessity for local man to consult central office for authority to settle routine problems. (c) Serious results may arise if there is lack of understanding of actual operating conditions by the officials in the central office. Best results are obtained with a minimum force in the central office, a maximum of responsibility placed with the local managers and the least possible exchange of forms, reports and correspondence that will enable the central office to intelligently guide the policies and operating practices of the individual companies.

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Retaining Wall Design

(Continued from page 18)

The amount of the overturning force depends upon the quantity of the material to be retained, its weight and angle of repose, and the weight and distribution of other loads to be carried. In this latter group would be included the weight of vehicles on a highway supported by the retaining wall. When such loads occur at a distance from the rear of the wall equal to the height h of the wall, they may be neglected in design. Theoretically this is true only when the angle of rupture of the material behind the wall is less than 1:1, or 45° but this assumption gives safe results in all other cases.

The general formulas for pressure on walls was given on page 33 of PUBLIC WORKS for August, 1933. The overturning moment in foot pounds is the product of this force and the lever arm measured perpendicular to the toe of the wall. The resisting movement is the weight of the wall times the horizontal distance from the toe to a vertical line through the center of gravity of the wall.

In the "Manual for Design of Armco Crib Walls" a simplified method of obtaining the overturning moment has been worked out for some of the usual cases based on Coulomb's theory, as follows:

TABLE I.

Surcharge	*Batter*	*Pressure*	*Thrust Angle*
1½ to 1	Vertical	$.45wh^2$	33° 42′
"	1″ per ft.	$.35wh^2$	28 56
"	2″ " "	$.30wh^2$	24 14
"	3″ " "	$.25wh^2$	19 14
None	Vertical	$.1306wh^2$	Horizontal
"	1″ per ft.	$.1131wh^2$	"
"	2″ per ft.	$.0955wh^2$	"
"	3″ per ft.	$.0831wh^2$	"

The point of application of the thrust, in all cases, is at 1/3h.

Using these data, which vary slightly from those obtained by using the formula given in the August, 1933, issue, typical examples are shown worked out graphically in Figs. 1, 2 and 3. The wall is drawn to scale and the various angles are measured by a protractor. P, the pressure or thrust tending to overturn the wall, is computed with the help of the above table, as shown. These and other examples in this article are taken from the Armco manual already mentioned. In solving such problems graphically, care must be used to measure all angles accurately.

The weight of the wall is determined by using its outside dimensions, computing the cubical contents and multiplying by the weight of the filling material. In the case of the surcharged walls, the weight of the earth directly above the top of the bins is added.

Inclining the wall toward the fill causes a decrease in the pressures, as shown by reference to Table 1. The more closely this inclination approaches the angle of repose of the material retained, the greater will be the reduction in pressure, and the increase in stability. For instance, with a wall 10 feet high and 4 feet thick, if the factor of safety with a vertical face is 0.98, with a slope of 1 inch per foot it will be 1.60; with 2 inches per foot, 2.12.

The construction of a crib wall with an inclination toward the fill also increases the factor of safety toward sliding. In addition to the product of the weight of the wall and the coefficient of friction with the earth, and the resistance of the earth in front of the wall, there is a resistance due to the fact that, with such an inclination, the wall must be pushed up-hill when sliding.

Pressures on the foundation at the toe are computed in the manner already described in the August, 1933, issue of this magazine.

Typical crib retaining wall designs are shown in Fig. 4, which illustrates the flexibility of this type of wall.

Curves can also be built into them, the radius of curvature depending upon the length of the units used. It is, of course, possible to build crib walls around corners.

In construction, the careful placing of the units, especially those forming the base or lowest course, is important. These should be placed true to line and grade, solidly bedded on good foundation soil. For the stretcher forming the bottom course, it is desirable to excavate a trench so that this will have a uniform bearing on the soil. It is not necessary to excavate the entire area within the crib. The trenches for the stretchers and headers are usually carried to a minimum depth of 18 inches, increasing with the height of the wall, about 6 inches for each additional 5 feet.

Backfilling and tamping are especially important. Earth should be placed in and behind the cribs as the walls are erected. Tamping should be started at the bottom and continued to the top, generally keeping the fill about one course below the top of the wall.

The Digestion Tank

(Continued from page 16)

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Effect on Fish Life of Sewage and of Treated Effluents

The effect of sewage pollution of streams on fish life was discussed by Carl L. Hubbs, director, Institute for Fisheries Research, University of Michigan, in a paper before the Michigan Sewage Works Assn., the purpose of which was to indicate: "*first,* the general failure to approach the problem of sewage treatment, in relation to fish life, with an open mind; *second,* the extreme difficulties encountered in determining the whole, varied ill-effects of sewage on fish life; *third,* the lack of any sound scientific basis for fixing a legal limit for pollution in terms of dissolved oxygen content, biochemical oxygen demand or any other single, simple test; *fourth,* the beneficial effects of sewage on fish life, in the increase of food organisms; *fifth,* the dovetailing of fishing, recreational, health and economic interests, as affected by sewage, treated and untreated."

The effect varies greatly with the season. When the water is very cold, fish are extremely resistant to the effects of pollution, usually surviving unless the dissolved oxygen beneath the ice is entirely or almost entirely exhausted for some time. With rapid rise of water temperature in the spring the fish become susceptible to unfavorable conditions; and in late summer, with high water temperature, they show reduced resistance to low oxygen and other pollution effects. "Unless a stream or lake approaches the character of an open sewer, fish deaths in it are usually confined to a very few days in the year, when the weather is very warm and the water level low."

The effect of sewage on fish life varies greatly with time of day. A badly polluted stream may often show over 100% saturation with dissolved oxygen, especially on sunny afternoons, and complete absence of dissolved oxygen during the night, especially toward morning. The author cited the lower Raisin river, badly polluted with sanitary and paper plant sewage, in which, during the night, "the dissolved oxygen became entirely consumed, anaerobic decomposition set in, hydrogen sulphide was produced and reacted with the reduced iron salts in the water to produce ferrous sulphide, so that the water ran foul and black before daylight. Then the sunlight fell upon the water, causing the algae to manufacture oxygen, which oxidized the ferrous sulphide to form white colloidal sulphur, so that the stream ran white instead of black."

Sewage may kill fish outright, or slowly, or kill the fry only or prevent the spawn from hatching. Or it may kill the animal life on which the fish live, and stunt their growth, or may drive them away. Certain chemicals may seriously affect the taste of fish.

Coarse fish, such as carp, may multiply in sewage-polluted waters, and tend to decrease the better fish, eating their eggs or fry, competing for food, etc.

"We cannot give the engineer any definite figure on the amount of dissolved oxygen which is just sufficient to support fish life." The killing limit varies with the kind of fish, the temperature, and the other matters dissolved in the water. Spawning fish are easily killed, and eggs and fry even more so.

A better standard is the oxygen reserve or excess of dissolved oxygen over B.O.D., a reserve of 3.0 ppm. being considered satisfactory; but it may be less, and even minus, and "be rather healthy for fish if the stream is frequently well aerated by flowing over riffles or dams. So far as I can see, no simple test for lower limit of allowable pollution may be fixed on any good scientific basis."

The problem is complicated by the fact that "most sewage, especially sanitary sewage, is at least potentially beneficial to fish life," since its fertilizing qualities increase aquatic vegetation, and through this the small animals on which the fish feed. "After the sanitary sewage of Chicago was diverted into the Illinois river, a marked increase in the commercial fish yield of that river was recorded," but when sludge accumulated on the bottom of the river the fish departed down stream, but are returning now that a considerable part of the sewage is being treated. Treatment of sewage eliminates the formation of sludge beds in the river or lake, while the effluent contains in solution much of the fertilizing properties in a form directly utilizable by water plants.

Water Consumption Data from New Bedford

In the report for the year ending Nov. 30, 1933, the Water Board of New Bedford, Mass., give some interesting figures on water consumption. The percentage of consumption metered is 84.3. The daily average consumption was 77.0 gallons per consumer, or 76.0 gallons to each inhabitant, with 432 gallons daily to each tap.

The average daily consumption amounted to 9,220,903 gallons. The daily average by months, expressed in percentages of the daily average for the year is as follows:

December	95.2%	April	83.4	August	111.5
January	95.0	May	97.0	Sept.	105.8
February	94.6	June	108.4	October	105.5
March	91.3	July	112.7	Novem.	101.0

The maximum day's consumption occurred on July 19, when 13,306,280 gallons were consumed, or 144.5% of the daily average. The minimum day's consumption of 6,019,900 gallons, or 65.1% of the average, occurred on April 23. Of the average daily consumption, 5,881,727 gallons, or 63.8%, was between the hours of 6 a.m. and 6 p.m.

The total cost of supplying water has been $91.56 per million gallons, including maintenance, interest on bonds and bond payments. For maintenance alone, the cost was $55.63; and for maintenance and bond interest $71.05. The average income per million gallons pumped has been $94.86.

Concrete Pavement Cured With Cement Spray

Searcy B. Slack

A new method of sealing the surface of concrete pavement for curing has recently been tried by the State Highway Board of Georgia. The surface of the pavement is sprayed just after finishing with a thin layer of neat cement paste. The theory is that the cement will seal the surface pores and retain the moisture necessary for curing. Test sections using this method were compared with others using the standard wet earth curing and also where only 24 hour wet burlap was used. Strength comparisons were made on cores at 28 days and electrical resistance measurements were made to indicate the amount of moisture retained in the slabs by the different methods. Core strengths for earth and water cure were 3,388 p.s.i., for cement spray 2,981 p.s.i. and for wet burlap 2,716 p.s.i. The resistance tests showed good correlation with the strength tests and indicate that a resistance method of measuring moisture on concrete for curing has interesting possibilities. —*Highway Research Board.*

Do you make regular use of the Readers' Service Dept.?—see pp. 34, 52, 53

Our Readers Ask

Unit cost data on municipal construction projects are asked for by Howard M. Capper, boro engineer, Camp Hill, Pa.; also F. T. Paul, city engineer of Minneapolis, Minnesota, and several others. A. F. Parrott, county surveyor, Yreka, Calif., asks for earthwork cost data. The editors will appreciate receiving for publication, from city and county engineers data showing both actual costs from force account work, and unit bid prices.

Our readers having information on the subjects mentioned below are requested to supply it, either direct to this office, or the man asking information, sending a carbon copy to this office.

C. L. Stone, city engineer, Pampa, Texas, asks for information on the value of digested sludge as fertilizer. Information on the practical utilization, and data on sales methods, prices, and amounts may be included.

"Saw an article some months ago about the use of copper sulphate for removing roots from sewers, and cannot locate it now. Can you help?" S. Allen McAdam, city engineer, Lebanon, Pa. The editors cannot locate this either; perhaps some of our readers can.

Letters to the Editor

Dear Sir:—Can you cite me any references in your magazine on the subject of laying water mains and sewer pipes in the same trench?—*L. M.*—New York.

It has been a number of years since PUBLIC WORKS has published anything concerning the laying of two pipes in one trench but at different elevations. The advantage of doing so is obvious. Among the disadvantages are:

If one is placed immediately above the other, it is difficult to reach the lower one for repairs or connections. It is very difficult to consolidate the back-fill over the lower one so compactly that it will not settle and carry the upper one down with it, possibly opening joints and breaking off house connections. A small leak in a joint of the upper water main would probably cause settlement under it and might even wash soil into a poor joint of the sewer below. In fact, should there be such a joint, there is almost sure to be soil carried into it and in time a settlement of the water main and possibly a break in same.

Placing the water main on a bench at one side of the sewer trench lessens these objections. But, unless it is rock, the bench may settle more or less, especially if the pipe is a large and heavy one. Another objection is that, in excavating an opening to either pipe line later on, either the full width of the original opening must be taken out, or else close sheathing must be used in bracing up the soil originally removed, since this will not be cohesive enough to stand up. Of course, if the soil is sand or other non-cohesive material, close sheathing is necessary in all cases and this objection does not apply. If the soil is running sand, rotten or otherwise unstable, requiring careful sheathing, the bench method is inadvisable, and the difficulty, expense and danger of original excavation are considerably increased. A narrow trench can first be dug for the sewer and back-filled up to the bench, and then the extra width be excavated down to the bench; but the sheathing complications would probably more than offset the advantages.

There is a little saving in both amount of material to be excavated and width of pavement to be removed and replaced in opening one trench instead of two; and if other things are favorable, and both pipes are to be laid at the same time, there may be a net advantage with the bench method and it has been used in a few cases. If the two lines are laid by different municipal departments there may be a conflict of authority or shifting of the responsibility for the maintenance of the trench and paving over it. It is desirable generally to turn this repaving over to the highway department, which can then charge the cost to the water and sewer departments.—*Editor.*

Darwin W. Townsend has entered private engineering practice as a member of the firm of Consoer, Older & Quinlan, 205 West Wacker Drive, Chicago, Ill., with offices to be located in Milwaukee. Mr. Townsend has resigned as Acting Chief Engineer of the Milwaukee and Metropolitan Sewerage Commissions and has been appointed by them as consulting engineer.

Frank W. Kennedy, vice-president and general manager of the De Laval Steam Turbine Co., Trenton, N. J., died at his home at Yardley, Pa., Jan 24, after a short illness. He was 57 years old, a graduate of Princeton, and since 1916 a vice-president of the De Laval Co.

Good Guard Rails An Economy

The better the road, the greater the necessity for adequate engineering in its construction, from base to guard rail, in order to provide safety for the traveling public. Damage to vehicles and injury to occupants can be greatly reduced by safe, visible and efficient guard rails.

The Tuthill Highway Guard has met the severest tests of a number of state highway departments. This convex steel guard, in addition to providing safety, requires a minimum maintenance expense. Maintenance cost figures will be sent on request. Compare them with your own figures for other types. Write Tuthill Spring Co., 760 Polk St., Chicago, Ill., for these data.

The guard rails can now be furnished for assembly with posts that are already in place and have been used for other types of rails.

No Damage Done

Material Prices

(*As of Feby. 20, 1934*)

Prices on cast iron pipe, net per ton. Class B, 6-inch and larger, AWWA specification*

Boston	$45.50	Baltimore	$43.50
New York	42.90	Atlanta	40.00
Chicago	44.00	Birmingham	36.00
Minneapolis	46.50	Kansas City	46.15

Burlington, N. J., $40.00; extra price for 4-inch, $3.00 per ton; extra for class A, $3.00 per ton.

**Information, courtesy U. S. Pipe & Foundry Co.*

Warehouse Prices on Reinforcing Steel and Structural Shapes

	Structural Shapes	*New Billet Reinforcing Bars*
New York	3.27c	2.52c
Boston	3.42	2.73
St. Louis	3.34	2.815
Cincinnati	3.30	.....

Base prices, per pound, subject to quantity discounts.

New Jersey Sewage Works Meets Soon

John R. Downes, well known secretary of the association and operator of Plainfield plant, writes in to say that the 19th annual convention will be held at Trenton, N. J., March 22 and 23. The program will consist of groups of papers ranged around the following: Activated sludge; sludge drying; atmospheric contamination, and chemical treatment.

The projected short school for sewage works operators planned by the New York State Sewage Works Association will not be held.

A. L. Struble has been appointed Sales Manager of the Truck Division of the Reo Motor Car Co., succeeding Carl Parker, resigned.

Readers' Service Department

To help you in your work, any of this **INDUSTRIAL LITERATURE** will be sent **FREE** upon request.

It is a good practice to check this list regularly because descriptions of new bulletins are always being added. ★

Construction Materials and Equipment

Asphalt Heaters

200. For general construction and maintenance, the Original Improved "Hotstuf" Asphalt Heater, an economical oil burning heater. Mohawk Asphalt Heater Co., 56 Weaver St., Frankfort, N. Y.

Bituminous Materials

229. A new series of concise and authoritative manuals of construction covering the latest developments in road-mix and surface treatment types as well as the standard asphalt pavements. These contain the best that has been developed by study, research and practical application in all types. Manual 1—Road-Mix Types is now ready for distribution. The Asphalt Institute, 801 Second Ave., New York, N. Y.

Brick, Paving

230. Full information and data regarding the use of vitrified brick as a paving material, cost, method of laying, life, etc. National Paving Brick Manufacturers' Association, National Press Building, Washington, D. C.

Concrete Curing

235. "How to Cure Concrete," is a manual of instruction on the curing of concrete pavements. 47 pages. The Dow Chemical Company, Midland, Mich.

Gutters

240. "Brick Gutters and Parking Strips." A study dealing with the problems faced in the proper construction of gutters and how they can be overcome. Covers design, construction and results. Well illustrated. Just issued by the National Paving Brick Ass'n, National Press Building, Washington, D. C.

Jacking Culverts

260. No interruption to traffic, and substantial savings in construction costs are the main advantages secured by using the Armco jacking method to install conduits, drainage openings, and passageways under streets, highways and railroads. "The Armco Jacking Method," describing this modern means of construction and its many applications, will be sent upon request, by Armco Culvert Mfrs. Association, Middletown, Ohio. Ask for Catalog No. 7.

Concrete Accelerators

30. "How to Cure Concrete," a forty-seven page manual published by the Dow Chemical Company, Midland, Michigan, treats fully subjects suggested by title.

31. "Curing Concrete Roads with Solvay Calcium Chloride," 30 page booklet. Comprehensive. Contains tables, illustrations, suggestions for testing devices. Covers the subject in considerable detail. Solvay Sales Corp., 61 Broadway, N. Y. C.

35. "A report on Current Practice of using Calcium Chloride for curing Concrete Pavements, Bridges, Culverts and Concrete Products." It includes reports from the Highway Research Board, the Bureau of Public Roads and State Highway Departments. Columbia Products Co., Barberton, Ohio.

Concrete Mixer

44. Concrete Mixers, both Tilting and Non-Tilting types, from 3½s to 84s size, The Jaeger Machine Company, Columbus, Ohio.

Crushers

57. Up-to-date information on Stone Crushers, Stone Spreaders, Unloaders, Drags and other contractors' equipment from the Galion Iron Works & Mfg. Co., E. Jeffry Mfg. Co., Columbus, Ohio.

Culverts

60. "In diameters up to 10 feet and larger . . ." just issued by the Armco Culvert Mfrs. Assn., tells a good deal about drainage problems and their solution. 32 pages about drainage and multi-plate culverts.

Explosives

74. "Use of Explosives for Settling Highway Fills. A new booklet which fully explains by diagrams and charts the three methods developed after many tests by the Du Pont engineers, which singly or in combination will quickly and efficiently do your job. Just issued by E. I. Du Pont de Nemours & Co., Inc., Explosives Dept., Wilmington, Del.

Graders

76. Latest information about Galion Motor Patrol Graders, Road Maintainers and Leaning Wheel Graders with hydraulic control is contained in a new series of illustrated catalogs, Nos. 125, 130, 135 just issued by the Galion Iron Works & Mfg. Co., care of The Jeffrey Mfg. Co., Columbus, Ohio.

Hose and Belting

87. Complete information on rubber hose and belting for all types of contracting and road building service. The Government Sales Department of the Goodyear Tire & Rubber Co., Inc., Akron, Ohio.

Joint Filler and Line Marker

88. Bulletin No. G-9 issued by Littleford Bros., 452 E. Pearl St., Cincinnati, Ohio, describes and illustrates their new No. 91 Joint Filler which is used to fill horizontal and center joints with hot asphalt. It can be equipped to apply an asphaltic center line as it fills the center joint. This bulletin also describes the Littleford Traffic Line Marker.

Joint Filling Pot

89. A supplement to Bulletin No. E-5 has been issued by Littleford Bros., 452 E. Pearl St., Cincinnati, Ohio, describing their cone-shaped crack filling pot No. 86-B. The chief feature of this pot is that it is springless—there is no mechanism to get out of order. It is used to fill cracks and joints in concrete pavements and interstices in brick or granite block pavements.

Loaders and Unloaders

97. Portable Loaders and Unloaders. Folders: Nos. 1248, 1298 and 1074 cover Belt Conveyors with channel iron and truss types of framework; No. 1076, Portable Bucket elevators for different classes of work; and No. 1256, the "Grizzly" Crawler Loader for heavy work and large capacities. Link-Belt Company, Philadelphia.

100. Materials Handling and Positive Power Transmission Equipment, giving technical data, list prices and illustrations of this machinery. Link-Belt Co., Chicago, Ill. General Catalog No. 500.

Motor Trucks

105. Full information about their complete line of motor trucks, all powered by six-cylinder "truck-built" engines of uniform valve-in-head design, will be sent promptly. General Motors Truck Co., Pontiac, Mich.

106. "Trucks for Public Utilities," is a new illustrated booklet just issued by the International Harvester Co., 606 So. Michigan Ave., Chicago. Covers uses, types, special equipment, bodies and specifications. Sent free on request.

Paving Materials

108. "Emulsified Asphalts" is a 56-page manual covering Penetration Type Construction, Road and Plant Mixes Pavements, Surface Tratments and Maintenance Methods. Includes 58 illustrations. Sent free by Headley Asphalt Division, Sinclair Refining Co., P. O. Box 66, Marcus Hook, Penn.

226. "Asphalt Surfacing Materials for Low-Cost Roads" is a handy, 28-page booklet illustrating the many types of road surfaces which can be constructed with Texaco asphalt materials. Well illustrated and contains tables of amounts of stone, sand and asphalt required. Sent promptly by the Texas Company, 135 East 42nd St., New York, N. Y.

109. A 36-page booklet with 66 illustrations has just been issued by the Barrett Co., giving full information regarding the making, laying and maintaining of "Tarvia-lithic," the ready-to-lay pavement.

111. "Tarvia Double Seal Pavements." Shows, step by step, the construction of a Tarvia pavement. 24 pages. The Barrett Company, 40 Rector Street, New York.

112. Complete directions for surface Cut Back Asphalt are contained in a 36 treatment and bituminous surfacing with page data book. Standard Oil Co. of Indiana, 910 So. Michigan Ave., Chicago, Ill.

Road Machinery

126. A new general reference catalog No. 1320 covering their entire line of equipment for every approved method of construction and maintenance has just been issued by Austin-Western Road Ma-

★Paste on post card and mail. 3-34

Readers Service Dept.
PUBLIC WORKS
310 East 45th ST., NEW YORK

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chinery Co., 400 No. Michigan Ave. No. A-5, Chicago, Ill. Profusely illustrated with action pictures showing each type of machine out on the job.

127. "Road Machinery Illustrated." New illustrated bulletins on the motor rollers, three-wheel and tandem rollers, motor graders powered by Caterpillar, Twin City, Cletrac, McCormick-Deering and Fordson tractors, and straight and leaning wheel graders. Galion Iron Works & Mfg. Co., Galion, O.

Rollers

132. A 32-page book in four colors featuring a complete line of road rollers. 8¾ x 11, leatherette cover, numerous action pictures. Buffalo-Springfield Roller Co. of Springfield, Ohio.

133. 20-page pocket size booklet showing all types of Buffalo-Springfield motor rollers and scarifiers and their uses.

134. "The Chief," a six cylinder roller of advanced design and construction is fully described in an illustrated catalog just issued by the Galion Iron Works & Mfg. Co., care of The Jeffrey Mfg. Co., Columbus, Ohio. Gives complete details of the very latest development by this company.

Sand and Gravel Washing Plants

140. Seventy-page catalog giving complete information regarding Sand and Gravel Washing Plants, stationary and portable. Those interested in such equipment should have a copy. Link-Belt Co., Chicago, Ill.

Shovels, Cranes and Excavators

145. The Austin Badger, a new, fully convertible ⅝ yard crawler shovel, made by The Austin-Western Road Machinery Co., 400 North Michigan Ave., No. A5, Chicago, is fully described and illustrated in their Bulletin No. 1236.

146. Link-Belt Co., Chicago, Ill., has issued Book No. 1095, which describes and illustrates their complete line of Gasoline, Electric, or Diesel operated shovels, cranes and draglines. 910 S. Mich. Ave.

Tires, Truck and Tractor

165. Speed and economy in use of solid, cushion and pneumatic tires and tubes for trucks, cars, tractors, graders and other road machinery. Government Sales Department of the Goodyear Tire & Rubber Company, Inc., Akron, Ohio.

Snow Removal

349. "The Answer to the Snow Removal Problem." It gives full details of the Frink type S snow plow for trucks. Carl Frink, Mfr. of Clayton, N. Y.

359. Galion Iron Works and Mfg. Co., Galion, Ohio. Details, prices and catalogs of their snow plows adaptable to any make of truck.

Sanitary Engineering

383. Loughlin Clarifying Tanks for the more complete removal of suspended solids from sewage and industrial wastes at lower cost are described in a new bulletin just issued by Filtration Equipment Co., 350 Madison Ave., New York, N. Y.

Sludge Drying

385. Relatively dry cake sludge in demand for fertilizer is produced by automatic continuous vacuum filters like those used in Milwaukee, Houston, Chicago, Gastonia, N. C., Charlotte, N. C. Write for literature. Oliver United Filters Inc., 33 West 42nd St., New York, N. Y.

Activation and Aeration

390. A booklet of value to sanitary and chemical engineers describes Norton Porous Mediums of bonded fused alumina (strong chemically stable, uniformly permeable) and their use in aeration of water and sewage. Norton Co., Worcester, Mass.

Glass Covers

393. Full details regarding the use of Lord & Burnham Glass-Overs at Middletown, N. Y.; Marion, Ohio; Cleveland, Ohio; Freeport, N. Y.; Kitchener, Canada; West Chester, Pa., and other places are given in bulletins 22 to 33. Sent promptly on request to Lord & Burnham Co., Irvington, N. Y.

Jointing Materials

402. Full details concerning No. 1 Korite for sealing sewer pipe joints so that they will be permanently tight. Standard Oil Co. of Indiana, 910 So. Michigan Ave., Chicago, Ill.

Manhole Covers and Inlets

403. Nuisance from loose, noisy manhole covers is eliminated by the use of Westeel rubber cushioned manhole covers and gratings. Six special advantages are explained in a new illustrated bulletin just issued by the West Steel Casting Co., 805 East 70th St., Cleveland, Ohio.

404. Street, sewer and water castings made of wear-resisting chilled iron in various styles, sizes and weights. Manhole covers, water meter covers, adjustable curb inlets, gutter crossing plates, valve and lamphole covers, ventilators, etc. Described in catalog issued by South Bend Foundry Co., South Bend, Ind.

Pumping Engines

413. "When Power Is Down," gives recommendations of models for standby services for all power requirements. Sterling Engine Company, Buffalo, N. Y.

Screens, Sewage

417. The simple, automatic, Loughlin self-cleaning traveling screen is fully described in a new bulletin just issued by Filtration Equipment Co., 350 Madison Ave., New York, N. Y.

418. Sewage screens (Tark, Brunotte, and Straightline) for fine and coarse sewage; Straightline Collectors for Settling Tanks (Sludge, Scum and Grit), and Mechanical Aerators for activated sludge plants. Link-Belt Company, 910 So. Michigan Ave., Chicago, Ill. Book 642.

419. An illustrated booklet showing installations, and complete details regarding the 19 exclusive improvements which are featured in Shevlin Fine Disc Screens will be sent promptly by the Shevlin Engineering Co., Inc., 227 Fulton St., New York, N. Y.

420. A useful new bulletin for all those interested in sewage disposal, describing some of their proven equipment such as self-cleaning bar screens, grit conveyors, sludge collectors and shredders, has just been issued by the Jeffrey Mfg. Co., Columbus, Ohio. Includes diagrams and many illustrations.

Screens

424. Water Screen Book No. 1252, describes water screens and gives complete technical information about them. Link-Belt Co., Chicago, Ill.

Sludge Bed Glass Covers

426. Sludge Bed Glass Covers—"Super-Frame." Hitchings & Co., Main Office, Elizabeth, New Jersey. Offer A. I. A. File 101SB, describing glass covers for sludge and sprinkler beds; details, specifications and cost data.

Sludge Conditioning

382. Full information concerning the experiences in the use of ferric chloride for use in sludge conditioning and in coagulating sewage will be sent promptly by Innis, Speiden & Co., 117 Liberty St., New York, N. Y.

Treatment

429. A new series of bulletins describing their full line of sewage treatment equipment—Fine Screens, Schofield Bar Screens, Vacuum Filters for Sewage Sludge, Decarie Screenings Incinerators, Schofield Bar and Fine Screens, Vacuum Filters for Sewage Filtration and Pneumatic Ejectors for Sewage Screenings—are ready for distribution on request to Municipal Sanitary Service Corp., Room 2703, 155 East 44th St., New York, N. Y.

430. Separate bulletins showing their many lines of sewage treatment equipment will be sent promptly by The Pacific Flush Tank Co., Chicago and New York. The latest is No. 110 describing tray clarifiers.

431. Eliminate sludge bed troubles, forget about weather conditions, odor nuisance, hail insurance and the like. Full details as to how Oliver United Vacuum Filters overcome these problems will be sent to all interested by Oliver United Filters Inc., 33 West 42nd St., New York, N. Y.

433. Collectors and concentrators for modern sewage treatment plants, recent installations, and full data on aerators, and screens. Link-Belt Co., 910 So. Michigan Ave., Chicago, Ill., and Philadelphia.

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For the Engineer's Library

The editors will be glad to assist readers in getting copies of publications mentioned here.

Amebic Dysentery, which is now a subject of much current interest, is very well covered in a radio talk given recently by Dr. J. D. Dowling, Health Officer of Birmingham, Ala. The etiology of the germ causing the disease, the methods of spread and other data are given in a complete and interesting manner. Copies of the paper can be obtained while they last by addressing K. W. Grimley, Health Department, Birmingham, Alabama.

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Mosquitoes and Mosquito Drainage is covered by Dr. T. H. D. Griffiths in an interesting article in "Health Notes" of the Florida State Board of Health. After describing the methods of spread of malaria, the article tells of the type of mosquitoes conveying malaria. Basic information on drainage, with illustrations, is included. Dr. Griffitts is one of the foremost experts in this field of work. We believe copies of this interesting and instructive paper can be obtained by addressing Dr. T. H. D. Griffitts, State Board of Health, Jacksonville, Fla.

• • •

Two interesting fully illustrated booklets, describing development and creation of water areas in cities or rural localities, for use primarily as small wild waterfowl refuges but adaptable to recreational, park and ornamental purposes as well, are available free of charge upon application to More Game Birds in America, Inc.—A Foundation, 500 Fifth Avenue, New York, N. Y.

The booklet "Small Refuges for Waterfowl" describes existing municipal, state and private refuges in widely separated sections of the country and how they were constructed by excavating, damming, blasting and other means. The booklet "Water Areas—How to Create and Maintain Them," describes simple methods of building small earth, rock and concrete dams of various types, earthen reservoirs and methods of developing water supplies to flood the ponds.

• • •

Taste and Odor Control is a matter of great interest to all water works superintendents—and city officials, too. Activated carbon has made a name for itself in this field. How, when and where it can and should be used to remove all kinds and tastes and odors from water supplies is told in a new booklet "Taste and Odor Control," just issued by the makers of Aqua Nu Char. 32 pages. Table, illustrations and usable data. Free on request. Industrial Chemical Sales Co., 230 Park Ave., New York.

Rodent Control is the title of a booklet just issued by the College of Agriculture of the University of California. While it refers especially to conditions in California, it contains many data that are applicable widely to other conditions. Ask for circular 79 in the series of the Agricultural Extension Service, College of Agriculture, University of California, Berkeley, Calif. This booklet was prepared by Prof. Tracy L. Storer.

• • •

CWA, PWA and Use of Explosives. In view of the fact that thousands of men hitherto unfamiliar with the uses of explosives on construction work are now employed by the CWA and on PWA projects, the DuPont Co. has issued a simplified set of instructions on blasting. These describe the physical characteristics of the various powders and dynamites and recommend the proper grades for the different uses. For instance, information is given on loosening earth so as to make it easier to handle by machines or by hand labor. Ditching, stump, and boulder blasting, and the use of dynamite in settling fills are also treated. This set of instructions can be obtained through this office or by request direct to E. I. duPont de Nemours Co., Wilmington, Del.

• • •

Road Stabilization Principles are concisely and graphically presented in a new publication by the Columbia Alkali Corporation, Barberton, O., which gives a lot of information on stabilization for secondary road construction of either gravel or slag. For those of us who want to familiarize ourselves with the terminology of stabilization and soil science, there is a glossary or list of definitions at the end. Also pictures and an interesting chart.

• • •

Sand and Gravel Preparation is treated in a new 64-page, copiously illustrated catalog issued by Link-Belt Co., Chicago, Ill. This covers mechanical handling, screening, sizing, washing, dewatering and preparation of sand, gravel, stone and other materials. Some new products are described. Like all Link-Belt publications, it is worth having. Book No. 1240. Sent on request.

• • •

Diesel Tractors are completely described in a new 44-page booklet issued by the Caterpillar Tractor Co., Peoria, Ill., stressing the new "35." Large model pictures and action photographs are combined with a complete description of both tractor and engine. Operating costs on diesels are very low.

Sewage Clarification by Vacuum Filters is a complete description of the recently completed filter plant, which is an adjunct to the activated sludge plant at Rockville Center, Long Island. This plant has excited a considerable amount of interest because it is the first of its type to be installed. The description by William Raisch gives the salient features of the installation, and some data on operation results; construction costs but not operating costs. Copies of the 24-page booklet will be sent on request to this magazine.

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Riding Comfort Analysis, which is one of the Engineering Bulletins of Purdue University, presents the progress to date of two related investigations: "Measurement of Vibrations in Vehicles" and "Effect of Vibration on Humans." It combines the results of these into a method for the numerical evaluation of riding comfort. The riding comfort of a vehicle may be evaluated by analysis of accelerometer readings. Data prepared by H. M. Jacklin and G. J. Liddell.

• • •

Tire Manual. The 1934 edition of the Truck and Bus Operators' Handbook has been issued by the B. F. Goodrich Co., Akron, Ohio. The contents include information of more or less technical nature to those interested in tire performance. It tells the right size and type of tire to use for every transportation need. 40 pages.

• • •

Floors and Their Care is the title of a 24-page bulletin put out by the Stonhard Co., Philadelphia, Pa., which gives a good deal of information on waterproofing, acidproofing and leveling floors. Sent on request.

Public Health Service Publications, 1933:

Among the publications issued by the U. S. Public Health Service during the period January-June, 1933, are the following:

1565. Experimental Studies of Water Purification. VI. General Summary and Conclusions. By H. W. Streeter. 24 pages. 5 cents.

1573. Rat Harborage and Relation to Bubonic Plague. By B. E. Holsendorf. 4 pages. Free.

1577. Malaria in the Irrigated Regions of New Mexico. By M. A. Barber and Louis Forbrich. 14 pages. Free.

1580. Experimental Studies of Natural Purification in Polluted Waters. VII. The Selection of a Dilution Water for Bacteriological Examinations. By C. T. Butterfield. 11 pages. Free.

99. Supplement to Public Health Reports: Citations to Public Health Law and Regulations, 1929-30. 30 pages. Free.

204. Public Health Bulletin. A study of the Pollution and Natural Purification of the Ohio River. IV. A Resurvey of the Ohio River between Cincinnati, O., and Louisville, Ky., including a discussion of the effects of canalization and changes in sanitary conditions since 1914-16. By H. R. Crohurst. 111 pages. 10 cents.

Publications for which a price is stated can be obtained from the Sup't of Documents, Government Printing Office, Washington, D. C. All others will be sent on request to the Surgeon General, Public Health Service, Washington, D. C.